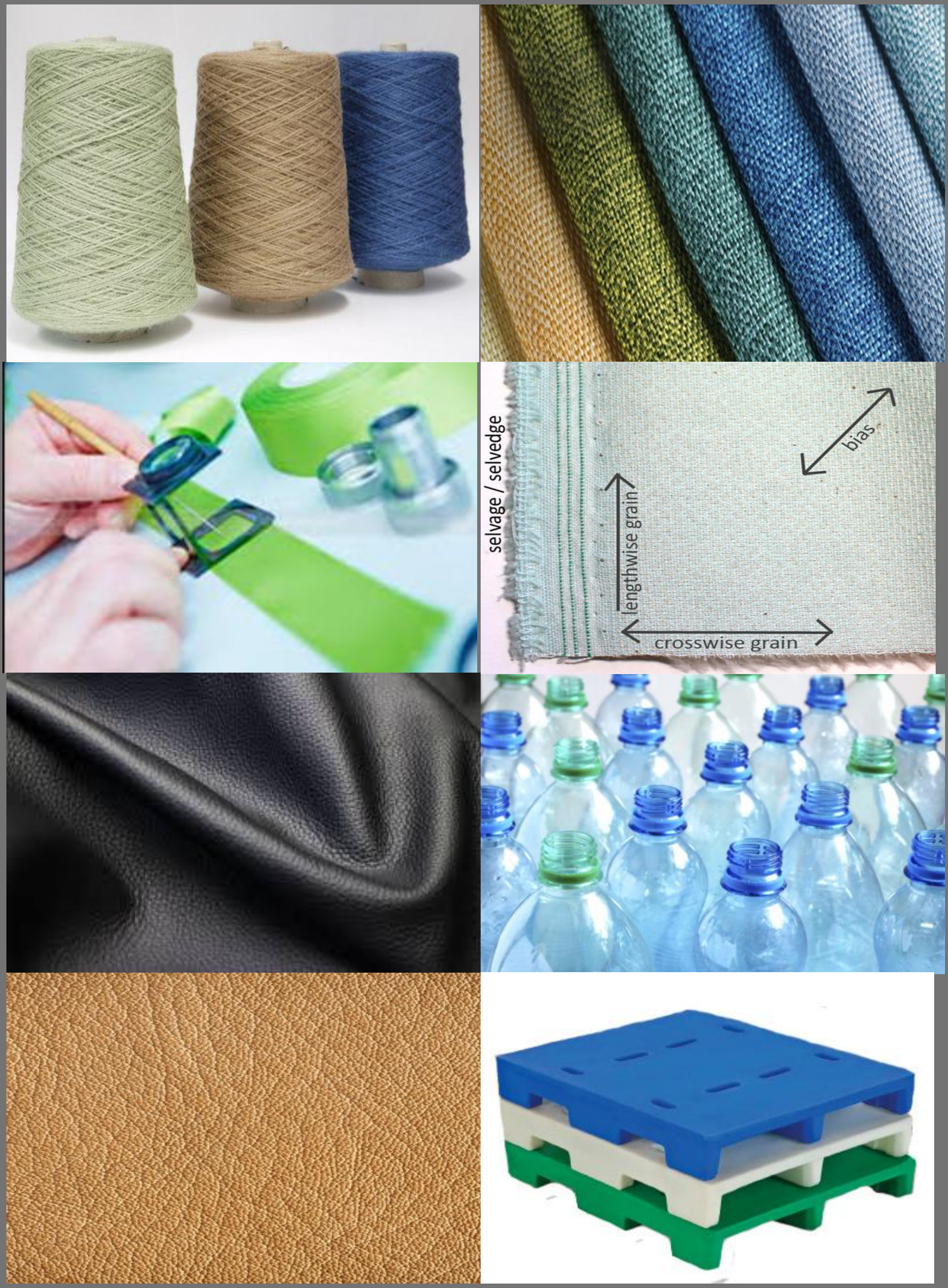
2019

HAND BOOK OF GS&C Stores (Textile ,Leather & Plastics)



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PREFACE

Since being new employee of inspectorate (1982) felt that there is need some sort of basic knowledge of textile, leather and plastic for all the employee of IAS&C as well as relevant ASIDs and Directorates.

This book is based on my experience of IAS&C labs and R&D Wing working (1982 - 2019). During writing this book, I have come to realized that there is so much that could be included, however, I followed my own advice based on experience to included summarize topics which are essential requirement for beginners knowledge.

Special thanks to my office colleges encourage me to write this book and also thanks God to complete this book at my retirement.

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UNIT 1 - TEXTILE

Chapter – 1

Textile

The word “textile” is described from the Latin word “textilis” and French word “texere” which means to weave. From the earliest times people have used textiles of various type for covering, warming and even to display personal wealth. Today textiles are still used for these purposes.

Now a days textile is freely defined as

“Any product made from the fibers and the name is applied to woven, knitted and all the fabric construction”

or

“ All the stages from fiber to manufactured item of clothing, decorative fabrication, woven or knitted ropes, cordages and threads”

1. **Textile Fiber**

   one of the delicate, hair portions of the tissues of a plant or animal or other substances that are very small in diameter in relation to there length. A fiber is a material which is several hundred times as long as its thickness and it can be spun into a yarn or made into a fabric by various methods including weaving, knitting, braiding, felting, and twisting.

   The essential requirements for fibers to be spun into yarn include a length of at least 5 mm, flexibility, cohesiveness, and sufficient strength. Other important properties include elasticity, fineness, uniformity, durability, and luster.

2. **Textile Yarn**

   When there is more than one fiber interlocked, it is called yarn. A long continuous strand of interlocked or twisted fibres is yarn - which could be used for knitting, weaving, braiding, crocheting, embroidering, stitching, textiles etc.

3. **Textile Fabric**

   When yarn is knitted or weaved or felted together, it becomes fabric. Fabric is a flexible material consisting of a network of natural or artificial (synthetic) fiber. Fabric is an artifact made by weaving or felting or knitting or crocheting natural or synthetic fibers. Thus, a fibre is the basic raw material for yarn - then yarn is the base for fabric and when a fabric is finished for a specific purpose, it is called **cloth**. So there is a linear development ,fiber → yarn → fabric → cloth

Textile Fiber

Fiber is raw material used in textile manufacturing. Fiber is slender filament or fine strand of sufficient length, pliability and strength to spun into yarns and woven in to cloth”. Textile technologists have defined a textile fiber as a slender filament or fine strand of sufficient length pliability and strength to be spun into yarns and woven into cloth

Fibers are composed of long chain molecules, which are very long compared to their breath and are flexible. A fabric made from fibers, which may either be converted into yarn first and then the yarn put together in one of variety of ways to make fabric or the fibers can be converted directly into fabrics.

Properties of Fiber

The utility of fibers both Natural and Man-made as textile raw material principally on the physical properties of the fibers, which include mechanical thermal optical and electrical properties. Some of these physical properties of fibers are molecular orientation, structure, length density, fineness, elasticity, breaking strength, moisture content, pliability, spin ability and elongation. Each fiber has its physical and chemical properties.

Classification of Fiber

Today there are so many types of fibers that some times is difficult even for an expert to identify them and to find the most suitable one for his particular purpose. Often the some fibers are known in many countries by different names. However fibers mainly be divided into two major groups.

1. **Natural Fiber**
    a. Animal (**wool**, silk)
    b. Plant (**cotton**, flax, jute),
    c. Mineral (asbestos, glass fibre)
2. Synthetic (**nylon, polyester, acrylic**)

1**.** **Natural Fibers**Natural fibers are further divided into following:

a. **Vegetable Fibers**

These fibers are called vegetable fibers because they contain a large amount of cellulose of which the cells of plant are constituted i.e Cotton, Flax, Linen and Jute etc.

(1) **Cotton**

It is white or yellowish white fiber, which is widely used in textile. Its fiber length varies. The longer the fiber length the finer the fabric. The finest cotton fiber is known in the world is Egyptian cotton.

(2) **Flax**

Fibers are obtained from the stem of the plant. After removing the bark the plants are subjected to retting, with this process the fiber get swallow.

(3) **Jute**

It is the bast fiber; nearly 80% of the world production of jute is produced by Bangladesh. After the cutting of the plant it is subjected to retting to loosen the fibers from the woody stalk. These fibers are very weak and short but smoother than flax. jute is mainly used for production of Hessian cloth.

b. **Animal Fibers**

These fibers are called animal fibers or protein fibers, obtained from animal kingdom. The fibers, which are most in use, are wool, silk and other hair of animal.

(1) **Wool**

It is the production covering of sheep. The sheep is almost found everywhere in the world. Wool is clipped from sheep by hand .The quality of wool depends on length, diameter, colour, luster strength and elasticity. The colour is usually white or yellowish white. Black and brown wools are also available and are known as GIGA WOOL.

(2) **Silk**

Silk is animal fiber .There are two varieties of silk worm cultivated and wild. Cultivated silkworm produced from yellowish to brown fibers.

c. **Mineral Fibers**

Asbestos

It is obtained from rocks in South Africa and Canada. Fabrics formed from asbestos fibers are fire proof; these are also used for industrial Gloves & Suits.

2. Man Made Fibers

Any fiber derived by a process of manufacture from a substance, which is at any stage in the process is not a fiber, is called Man Made Fiber. Man-made fibers are further divided into following.

a. **Derived from Cellulose**

Acetate

A manufactured fiber formed by a compound of cellulose re-fined from cotton linters and /or wood pulp, and acetic acid that has been extruded through a spinneret and then hardened.

b. **Chemically Derived**

(1) **Nylon**

First synthetic fiber developed known for its strength and excellent resilience; nylon has superior abrasion resistance and high flexibility.

(2) **Acrylic**

Fiber derived from polyacrylonitrile. Its major properties include soft, wool like hand machine washable and dryable excellent colour retention. Solution dyed versions have excellent resistance to sunlight.

(3) **Polyester**

A Category of polymers that contain the ester group functional in their main chain. As a specific material**,** it most commonly refers to a type called polyethylene terephthalate (PET). Polyesters include naturally occurring chemicals, as well as synthetics such as polybutyrate**.** The material is used extensively in clothing.

c. **Derived from Natural Substance**

(1) **Rubber**

Rubber fiber is manufactured fiber in which the fiber-forming substance is comprised of natural or synthetic rubber. The treated rubber is produced in strands, so that the cross section is either round or square and longitudinal surface is relatively smooth. It is used to make certain elastic fabrics.

(2) **Glass**

Natural minerals such as silica sand, lime stone, soda ash etc have been fused under very high temperatures into glass. Glass fiber is inert and highly flame-resistant.

Common Materials Used in Textile

Wool Fiber

Wool fiber is the natural hair grown on sheep and is composed of protein substance called as keratin. Wool is composed of carbon, hydrogen, nitrogen and this is the only animal fiber, which contains sulfur in addition.

The wool fibers have crimps or curls, which create pockets and give the wool a spongy feel and create insulation for the wearer. The outside surface of the fiber consists of a series of serrated scales, which overlap each other much like the scales of a fish. Wool fiber exteriors are hydrophobic (repel water) and the interior of the wool fiber is hygroscopic (attracts water)

Wool is the only fiber with such serration's which make it possible for the fibers to cling together and produce felt. Wool's scaling and crimp make it easier to spin the fleece by helping the individual fibers attach to each other, so they stay together. Because of the crimp, wool fabrics have greater bulk than other textiles, and they hold air, which causes the fabric to retain heat. Wool has a high specific thermal resistance, so it impedes heat transfer in general. Wool has several qualities that distinguish it from hair/fur. The amount of crimp corresponds to the fineness of the wool fibers.

Wool fibers readily absorb moisture, but are not hollow. Wool can absorb almost one-third of its own weight in water. Wool absorbs sound like many other fabrics. It is generally a creamy white color, although some breeds of sheep produce natural colors, such as black, brown, silver, and random mixes.

Wool ignites at a higher temperature than cotton and some synthetic fibers. It has a lower rate of flame spread, a lower rate of heat release, a lower heat of combustion, and does not melt or drip]it forms a char which is insulating and self-extinguishing, and it contributes less to toxic gases and smoke than other flooring products when used in carpets. Wool carpets are specified for high safety environments, such as trains and aircraft. Wool is usually specified for garments for firefighters, soldiers, and others in occupations where they are exposed to the likelihood of fire. Wool causes an allergic reaction in some people.

The quality of wool is determined by its fiber diameter, crimp, yield, color, and staple strength. Fiber diameter is the single most important wool characteristic determining quality and price.

Wool is also separated into grades based on the measurement of the wool's diameter in microns and also its style. These grades may vary depending on the breed or purpose of the wool. Any wool finer than 25 microns can be used for garments, while coarser grades are used for outerwear or rugs. The finer the wool, the softer it is.

In addition to clothing, wool has been used for blankets, horse rugs, saddle cloths, carpeting, insulation and upholstery. Wool felt covers piano hammers, and it is used to absorb odors and noise in heavy machinery and stereo speakers. Ancient Greeks lined their helmets with felt, and Roman legionnaires used breastplates made of wool felt.

Wool Processing

1. **Shearing**

   Sheep shearing is the process by which the woolen fleece of a sheep is cut off. After shearing, the wool is separated into four main categories. The quality of fleeces is determined by a technique known as wool classing, all Merino fleece wool is objectively measured for micron, yield ,staple length, staple strength, and sometimes color and comfort factor.

2. **Scouring**

   Wool straight off a sheep, known as "greasy wool" or "wool in the grease", contains a high level of valuable lanolin, as well as the sheep's dead skin and sweat residue, and generally also contains pesticides and vegetable matter from the animal's environment. Before the wool can be used for commercial purposes, it must be scoured, a process of cleaning the greasy wool.

Woolens and Worsteds

Woolen and worsted are two different classifications of wool fabrics and yarn.

1. **Woolen Fabric**

   Woolen fabrics have a soft feel and fuzzy surface, very little shine or sheen, will not hold a crease, and are heavier and bulkier than worsteds. Blankets, scarves, coating, are from woolen yarns.

2. **Worsted Fabric**

   Worsted fabrics are smoother than woolen, takes shine more easily, does not sag, holds a crease well, is lighter and less bulky, and wears longer than woolen. Fine worsted wool is even seen in clothing for athletics.

Classification of Wool

The quality of wool fibers produced is based on the breeding conditions, the weather, food, general care etc. For example, excessive moisture dries out natural grease. Similarly the cold weather produces harder and heavier fibers. The wool could be classified in two different ways.

1. By sheep from which it is obtained
2. By fleece

Classification by Sheep

The wool is classified as class one to four according to the sheep from which it is sheared class one is Merino wool

Classification by Fleece

The classification by fleece are lamb, hogget,wether,pulled dead, cotty and tag wool. Lamb’s wool which is 50mm or shorter from the first shearing of a sheep, at around the age of seven months. It is soft, elastic, and slippery, and is used in high-grade textiles.

Physical Properties

Colour : Fiber may be white, near white, brown and black.

Flame reaction : Odor of burnt horn

Luster : Luster of course fiber is higher than fine fiber.

Moisture Regain : 13-16% , very absorbent, decrease strength when wet, seem warmth, will shrink in washing.

Feel on Hand : Soft.

Resiliency : Excellent (due to crimp)

Abrasion resistance : Good.

Dimensional stability : Bad (For tendency of felting).

Effect of Heat : Heat affects the wool fiber greatly.

Effect of Sun Light : The fibers become discolored and develop a harsh feel.

Chemical Properties

1. **Effect of Acids**

   Wool is attacked by hot concentrated sulphuric acid and decomposes completely. It is in general resistant to mineral acids of all strength even at high temperature though nitric acids tend to cause damage by oxidation.

2. **Effects of Alkalis**

   The chemical nature of wool keratin is such that it is particularly sensitive to alkaline substances. Wool will dissolve in caustic soda solutions that would have little effects on cotton. Strong alkaline affect on wool fiber but weak alkaline does not affect wool.

3. **Effect of Resistance to Compression**

   Resistance to compression values are useful in assessing the suitability of wool for specific end uses.

4. **Effect of Resilience**

   Wool fibers can be stretched up to 50 percent of their original length when wet and 30 percent when dry.

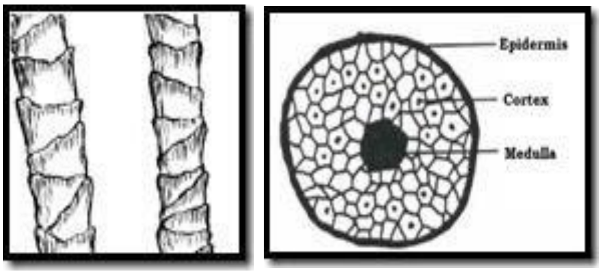
5. **Effect of Organic Solvent**

   Wool does not affect in organic solvents.

6. **Effects of Insects**

   Wool affected by insects.

7. **Microscopic view**



   a. **Longitudinal View**

      Cylindrical, irregular, rough surface, scale-like structure, dark medulla may appear on coarse wool fibers

   b. **Cross-Sectional View**

      Nearly round or circular, medulla may appear

8. **Effect of bleach**

   Chlorine bleach is ordinary harmful to the wool. KMnO4, Na_2O_2 are utilized for bleaching.

9. **Effect of Micro Organism**

   It is affected by mildew if it remains wet for long time.

10 **Dyeing ability**

   Wool absorbs many different dyes deeply, uniformly and directly without the use of other chemicals. Because of this ability, wool is known for the beautiful, rich colors that can be achieved.

11. **Effect of Colorfastness**

   Like cotton wool is easy to dye. Acid dyes, chrome and mordant dyes are utilized to dye this. The dye molecules are attracted into the amorphous areas of wool.

Characteristics of Wool

1. Flexible fiber
2. Good moisture absorbency
3. Good dyeing fastness
4. Wrinkle resistant
5. Non - flammable
6. Soft hand
7. Sensitive to the sun
8. Bad rubbing resistance
9. Tendency to pilling
10. Tendency to deformation
11. Tendency to shrink

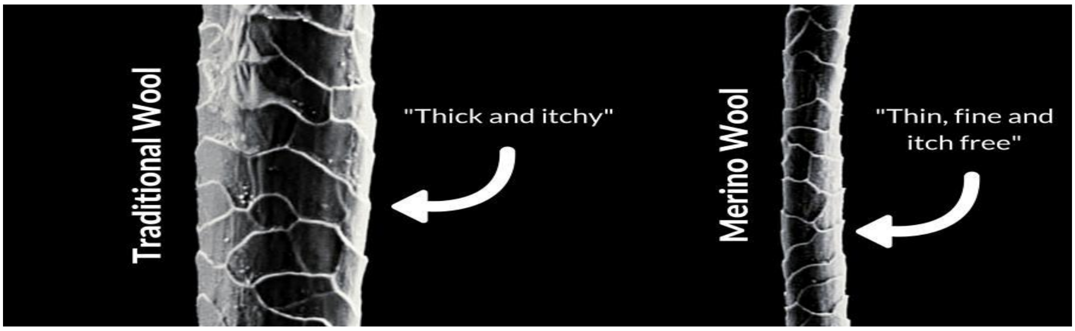
Merino Wool

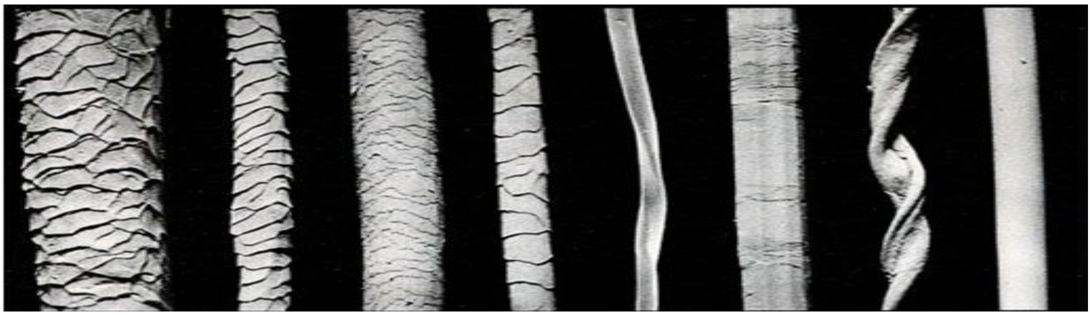
The term merino is widely used in the textile industries. Merino wool is a very specific type of wool that comes from Merino Sheep, is one of the most historically relevant and economically influential breeds of sheep, much prized for its wool.

Merinos are still regarded as having some of the finest and softest wool of any sheep. The Merino is an excellent forager and very adaptable. Merino wool is fine and soft. Staples are commonly 65–100 mm (2.6–3.9 in) long.

What makes Merino wool and these sheep so unique is they have thrived for hundreds of years in areas with extremely harsh climates, much too harsh for any other breed of sheep to operate. The majority of Merino sheep are found in the high altitude, mountainous areas of Spain, Australia and New Zealand, where temperatures range from below zero to over 100 degrees Fahrenheit! This has forced the Merino sheep to naturally adapt a fleece that keeps them cool and dry when its warm, and warm and dry when it’s cold.

Merino wool is three times finer than the human hair, making it incredibly soft and perfect for our next to skin base layers and selection of Merino tees. Merino wool is also elastic, allowing it to move with you outing after outing.





Corse wool **Fine wool** **Alpaca** **Cashmere** **Silk** **Linen** **Cotton** **Polyester**

Properties of Merino Wool

1. **Anti- odor**

   Because Merino wool is so good at climate control and moisture management, it never gives order causing bacteria the moist environment it needs to develop. Odor causing bacteria are also more attracted to smooth, positively charged fibers, whereas Merino fibers are scaly and carry no charge, sending the stank packing. Look good, smell good. Yes, please.

2. **Breathable**

   Merino is a highly breathable fabric. It can wick moisture away from the body and disperse it into the air to help you stay dry. It is also efficient at releasing body heat when you’re too hot, which makes it great for temperature regulation.

3. **Antibacterial**

   Its natural anti-bacterial properties will help you stay fresh. Its composition will allow sweat to stay on the surface without the unwanted smells. This makes it ideal for physical activities such as hiking and skiing.

4. **Light weight & Soft**

   Merino is finer than most sheep’s wool, which gives it a very soft feel. These fine properties can also reduce the itchiness that many people associate with traditional wool, making it very comfortable for wear as a base layer against the skin.

5. **Warmth**

   Merino wool contains crimps which hit each other as you move, creating pockets which trap air. Air that can’t circulate will retain heat from your body to keep you warm. Merino will also maintain it’s insulating properties when damp.

6. **Easy Maintenance**

   The majority of Merino products are machine washable and many can be tumble-dried.

Cotton Fiber

Cotton is a soft, staple fiber that grows in a form known as a boll around the seeds of the cotton plant, a shrub native to tropical and subtropical regions around the world, including the Americas, India, and Africa. The fiber most often is spun into yarn or thread and used to make a soft, breathable textile, which is the most widely used natural-fiber cloth in clothing today. Each cotton fiber is composed of concentric layers. The cuticle layer on the fiber itself is separable from the fiber and consists of wax and pectin materials.

Cotton is a soft fiber that grows around the seeds of the cotton plant. Cotton fiber grows in the seed pod or boll of the cotton plant. Each fiber is a single elongated cell that is flat twisted and ribbon-like with a wide inner hollow (lumen).

1. 90% cellulose, 6% moisture and the remainder fats and impurities.
2. The outer surface is covered with a protective wax-like coating which gives fiber an adhesive quality.

Cotton is a crop that requires adequate moisture and heat to mature and produce quality fibers. Cotton growing tends to be in warmer climates. Cotton is a true commodity in the world markets and supply and demand truly affect prices of raw cotton.

Cotton fibers are mainly made up of cellulose. Cellulose does not form unless temperatures are over 70 °F (21 °C). The cotton fibers are attached to the seeds inside the boll of the plant. There are usually six or seven seeds in a boll and up to 20,000 fibers attached to each seed. The length of these fibers (also called staples) is the main determining factor in the quality of the cotton. In general, the longer the staple grows the higher the quality of the cotton. Staple lengths are divided into short, medium, and long (and extra long, in some cases):

1. Short staple cotton is between 3/8” to 15/16” (.95cm to 2.4cm) in length
2. Medium staple cotton is between 1” to 1-1/8” (2.54cm to 2.86cm) in length
3. Long staple cotton is between 1-3/16” to 2-1/2” (3cm to 6.35cm) in length

PHYSICAL PROPERTY

1. **Length**

   Length of cotton fiber varies form ½” to 2½” and depends on the variety.

2. **Lustre**

   Due to the wax present in the raw cotton, it has little or no lustre. Bleached cotton is slightly more lustrous, while mercerised cotton is quite lustrous, especially when stretch mercerised.

3. **Strength**

Cotton is moderately strong fiber. Its strength is due to the presence of crystalline regions (65 - 70%), a fibrillar structure and a moderate degree of orientation. The dry tenacity is 27 to 44 gf/tex (9 gf/tex = 1 gf/d). The wet tenacity is 30 to 48 gf / tex. Cotton thus shows a 10% increase in tenacity when wet. This is an advantage as no special care in fiber handling is required during wet – treatment.

4. **Elasticity**

Plastic Nature. It is inelastic (poorly elastic) due to its crystalline polymer system; cotton fabric thus wrinkles and shrinks easily unless specially finished to overcome this tendency.

5. **Elongation**

Cotton has an elongation – at – break of about 7%. The elongation increases by about 10% when the fiber is wet.

6. **Hygroscopic Nature**

Cotton fiber is very absorbent. This is due to the presence of polar –OH groups which attract water molecules

7. **Moisture Regain**

Cotton has a moisture regain of 7 – 6.5% in standard atmosphere (65% relative humidity and 20^{0}C).

8. **Heat Conductivity**

Cotton is a good conductor of heat. It therefore feels cool to the touch and is ideally for summer wear.

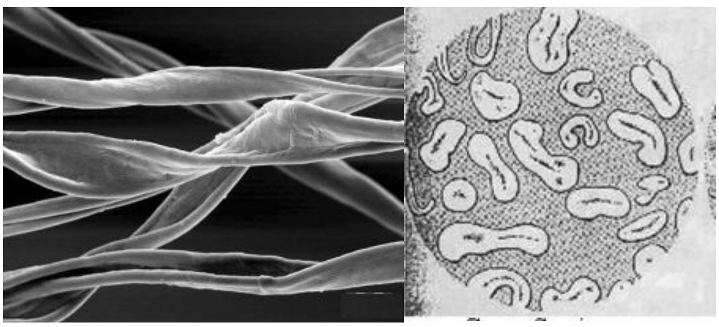
9. **Color**

Its color varies from white of cream, depending on the variety and cultivation conditions.

10. **Diameter**

The fiber diameter (ribbon width) various from 11mm to 22mm. The finer cottons are generally longer and the coarser ones shorter.

11**.** **Microscopic Appearance**



a. Longitudinal View

Mature cotton looks like a flat, twisted, ribbon or a collapsed twisted tube. A large number of convolutions are usually found. Immature cotton also looks like a flat twisted ribbon but has a lower number of convolutions. Mercerised mature cotton is almost cylindrical in shapes and has very few convolutions.

b. Cross Sectional View

Mature cotton has been or kidney – shaped cross section, and a small lumen. Immature cotton also has a bean – shaped cross section but a larger lumen. Mercerised cotton looks almost round to oval, a small point at or near the centre representing the lumen.

CHEMICAL PROPERTIES

1. Chemical composition of raw cotton :

a. Cellulose = 88 – 97 %

b. Protein = 1 – 2 %

c. Oil and wax = 0.4 – 1.5 %

d. Pectin = 0.4 – 1.5 %

e. Minerals = 0.7 – 1.6 %

f. Others = 0.5 – 0.6 %

2. Effect of Acids

Cotton fibers are weakened and destroyed by acids. This is due to the hydrolysis of cotton polymer at glucoside oxygen atoms and the formation of hydrocellulose. The DP is lowered by such hydrolysis and these results in lower strength.

a. Concentrated acids like HNO_3, H_2SO_4 and HCI destroy the fiber easily.

b. Cold dilute acids like HNO_3, H_2SO_4 and HCL destroy the fiber easily.

c. Organic acids have little effect on cotton

3. Effect of Alkalis

Cotton fibers are much more resistant to alkalis. Concentrated alkalis do not normally harm cotton. Concentrated sodium hydroxide in particular causes the cotton fibre to swell.

4. Effect of Sunlight

Cotton loses its strength and has a tendency to become yellow with prolonged exposure to sunlight.

5. Affinity of dyestuffs

Cotton is considered to be a relatively easy fiber dye and print. This is due to the presence of polar chemical groups in the polymer. Direct, napthol, vat, reactive and sulphur dyes can be applied to cotton.

6. Resistance to Microbiological Attack

Cotton is readily attacked by mildew and bacteria if stored in hot humid conditions. Sized cotton is very readily attacked. Mildew affected cotton shows yellowish stains, reduced strength and uneven dye-ability.

7. Effect Of Bleaching Agents

If bleaching agents are used with care and control with regard to concentration, pH, temperature and time, cotton is not damaged. If any or these variables goes out of control, chemical damage occurs, oxy-cellulose is formed and the fiber weakens. Cotton is readily bleached by solutions of sodium and calcium hypochlorite peroxide and sodium chlorite.

8. **Effect of Water**

   Cotton is not affected by water even under boiling condition. It can thus withstand normal washing and laundering treatments repeatedly.

9. **Effect of Heat**

   Cotton can withstand dry heal up to 140^{0}C. At 245^{0}C, it scorches and burns. Cotton textiles can thus withstand domestic ironing without yellowing provided that their contact with the hot iron is kept to the required minimum

Long Staple Cotton

In general, long staple cotton is needed to spin the yarns needed in the weaving of the finer down proof cotton fabrics. Long staple cotton is considered to be finer quality because they can be spun into finer yarns and those finer yarns can be woven into softer, smoother, stronger, and more lustrous fabrics. Long staple cotton makes stronger yarns, especially in fine yarns.

Uses of Cotton

Cotton is used extensively throughout the world in the form fiber, yarn and fabric. Its used in various forms are given below:

1. **Fiber**
   a. Surgical cotton used in the medical field - Wadding (fiber-fill) used in pillows and mattresses.
   b. Cotton Linters - Cotton linters are the very short fiber bits removed from the seed during the second ginning process. The linters are too short to be spun into yarn.

2. **Yarn**

   Used as sewing threads, cords, tapes and twines.

3. **Fabric**
   a. **Apparel Field -** Dress wear and inner garments.
   b. **Household -** Bed sheets, towels, carpet and bags.
   c. **Industrial -** Used in the manufacture of tyre-cord fabric, canvas sheeting, book

Cotton Blends

Cotton can be blended with almost any other fiber to form a useful textile.

1. cotton + polyester
2. cotton + wool
3. cotton + spandex
4. cotton + nylon
5. cotton + silk
6. cotton + linen
7. cotton + nylon + spandex
8. cotton + nylon + wool

Polyester Fiber

Polyester is defined as a manufactured fiber in which the fiber forming substance is any long-chain synthetic polymer made of at least 85% by weight of an ester. As a specific material, it most commonly refers to a type called polyethylene terephthalate (PET) Polyester can also be classified as saturated and unsaturated polyesters. The material is used extensively in clothing.

Polyester is a popular synthetic fabric. Synthetic means it is not grown naturally or available freely in nature, unlike cotton and other fabrics that occur naturally. Polyester, a polymer made of petroleum, coal, air and water, is a fabric that used in association with other textiles to add certain qualities. It is also used to harden other fabric materials and give them strength.

Types of Polyester

Depending on the chemical structure, polyester can be a thermoplastic or thermoset**.**

1. **Thermoplastic Polyester**

   Thermoplastics polyesters may change shape after the application of heat. While combustible at high temperatures. the most common polyesters are thermoplastics

2. **Thermoset Polyester**

   Thermosetting polyesters are used in the liquid state, in sheet molding compounds**,** as fiberglass laminating resins and in non-metallic auto body fillers, bodies of yachts and as body parts of cars. Polyester, being a synthetic fiber, is a less expensive option and has many benefits that cotton does not.

Properties of Polyester

1. **Tenacity**

   Polyester filaments and staple fiber are strong due to their crystalline nature. The crystalline nature permits for the formation of highly effective Vander wall's forces as well as since hydrogen bonds which provided the fiber its good tenacity. The tenacity remains unchanged when wet since the fiber resists the entry of water molecules to a significant extent.

2. **Elastic plastic nature**

   The very crystalline of the fiber prevents wrinkling and creasing. Repeated stretching and straining causes, distortion of the polymer system as the Vander wall's forces cannot withstand much stretching.

3. **Hygroscopic nature**

   Filaments and staple fibers are hydrophobic. The lack of polarity and the very crystalline structure resists the entry of water molecules into the polymer system. The hydrophobic nature of the polymer system attracts fats, greases, oils, acid or any other greasy soils. It is believed to be oleophilic. The oleophilic nature makes it not easy to remove grease by soap but by dry-cleaning with organic solvents.

4. **Thermal properties**

   It is a poor heat conductor and it has low resistance to heat. It melts on heating. Polyester textile materials can be permanently heat-set. It is a thermoplastic fiber meaning that it is capable of being shaped or turned when heated. Thermoplastic fibers heated under strictly controlled temperatures soften and can then be made to similar to a flat, creased or pleated configuration. When cooled thermoplastic fibers retain the new configuration.

5. **Effect of acids**

   These polymers are resistant to acids.

6. **Effect of alkalis**

   Alkaline conditions as seen in laundering hydrolyses the ester groups in polyester polymers. The crystalline nature prohibits hydrolysis to a greater extent and it is the surface of filament which gets hydrolyzed. Continued laundering results in hydrolysis and materials get fewer as the surface film of the fiber gets lost.

7. **Effect of bleaches**

   It does nor require bleaching. It retains its whiteness and requires only chlorine bleaches to be used when essential.

8. **Effect of Sunlight**

   It withstands the sun's ultra-violate radiations and is resistant to acidic pollutants in atmosphere.

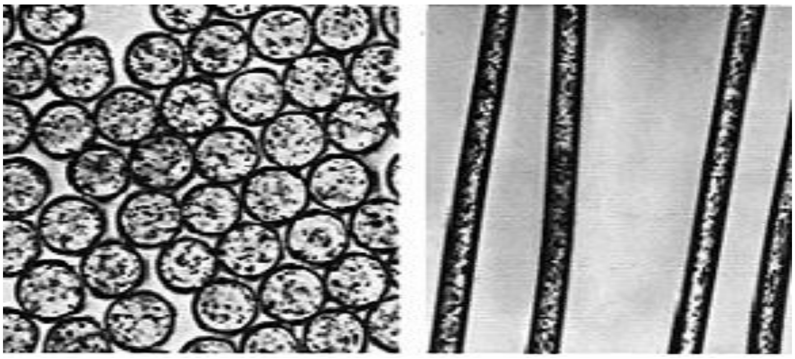
9. **Color Fastness**

   It is not easy for dye molecule to penetrate the fiber when dyed, it retains its color after regular wash.

10. **Micro-Organisms:**

    It is resistant to bacteria and other mcro-organisms.

11. **Microscopy**



    a. **Longitudinal View**

       Structure less, uniform diameter, rod-like appearance

    b. **Cross-Sectional View**

       Circular

12. **Characteristics of Polyester**

    a. Flexible
    b. Strong
    c. Dries quickly
    d. Resists wrinkles and shrinking
    e. Inexpensive
    f. Tends to stick to perspiring skin

g. Not as breathable

h. Temperature sensitive

i. Subject to dye migration

Blends of Polyester

So what is the answer? Cotton or poly? Cotton/Polyester blends are the best of both worlds. Take the breathability and natural feel of cotton and mix it with the strong, flexible and more cost effective properties of polyester. No wonder a 50/50 shirt is the most popular choice among garment decorators. A nice 50/50 cotton/poly shirt like

Uses of Polyester

Fabrics woven or knitted from polyester thread or yarn are used extensively in apparel and home furnishings, from shirts and pants to jackets and hats, bed sheets, blankets, upholstered furniture and computer mouse mats.

Industrial polyester fibers, yarns and ropes are used in car tire reinforcements, fabrics for conveyor belts, safety belts, coated fabrics and plastic reinforcements with high-energy absorption. Polyester fiber is used as cushioning and insulating material in pillows, comforters and upholstery padding. Polyester fabrics are highly stain-resistant—in fact, the only class of dyes which *can* be used to alter the color of polyester fabric are what are known as disperse dyes.

Polyesters are also used to make bottles, films, tarpaulin**,** canoes, liquid crystal displays**,** holograms**,** filters**,** dielectric filmfor capacitors**,** filminsulation for wire and insulating tapes.

PET Polyester

Ethylene terephthalate, or PET, is the most popular type of polyester used for fabrics. This is the same material as the one used for making disposable water and soft drink bottles. To make PET polyester, ethylene glycol is mixed with either terephthalic acid or methyl ester along with an antimony catalyst.

An antimony catalyst is a substance, produced primarily in China, that causes the chemical reaction to occur that forms the polyester fabric. If the material is used as a fabric, it has to have a high molecular weight so this reaction needs to occur at high temperature in a vacuum. The major advantage of this material is that it can be recycled. This can save considerable time in the production process.

PCDT Polyester

PCDT polyester uses a chemical combination called poly-1, 4-cyclohexylene-dimethylene terephthalate. This type of polyester fabric is not as popular as PET, but is used nevertheless as a type of polyester because it offers the fabric greater resilience and elasticity.

PCDT polyester is ideal for heavier textiles such a curtains and furniture coverings. To create PCDT polyester, acid is mixed with a combination of several chemicals, including poly-1, and 4-cyclohexylene-dimethylene terephthalate. When the acid mixes with the chemicals, a chemical reaction occurs, called a spin melt, in which the polyester is produced.

Nylon Fiber

Nylon is a generic designation for a family of synthetic polymers, based on aliphatic or semi-aromatic polyamides. Nylon is a thermoplastic silky material that can be melt-processed into fibers, films**,** or shapes. It is made of repeating units linked by amide links similar to the peptide bonds in proteins.

Nylon polymers can be mixed with a wide variety of additives to achieve many different property variations. Nylon polymers have found significant commercial applications in fabric and fibers (apparel, flooring and rubber reinforcement), in shapes (molded parts for cars, electrical equipment, etc.), and in films (mostly for food packaging).

Nylon was the first commercially successful. synthetic thermoplastic polymer. DuPont began project in 1927 and Nylon 6,6 was produced in 1935 ,later on developed Nylon 6

Nylon was first used commercially in a nylon-bristled toothbrush in 1938,followed more famously in women's stockings or "nylons" which were shown at the 1939 New York World's Fair and first sold commercially in 1940. During World War II, almost all nylon production was diverted to the military for use in parachutes and parachute cord**.**

Properties Nylon Fabrics

1. **Strength**

   Nylon has good tenacity and the strength is not lost with age. Nylon has a high strength to weight ratio. It is one of the lightest textile fibers is at the same time also one of the strongest. The strength of the nylon fabric is lost when wet. Nylon has excellent abrasion resistance.

2. **Elasticity**

   Nylon has good elasticity which makes it much suitable for the apparel purposes. The excellent elasticity would mean that the nylon materials return to their original length and shreds the wrinkles or creases. If stretched too much, it will not completely recover its shape. The high elongation and excellent elastic recovery of nylon contributes to the outstanding performance in hosiery. Nylon hosiery recovers to its original shape at knees and ankles instead of bagging.

3. **Resilience**

   Nylon fabrics have excellent resilience. Nylon fabrics retain their smooth appearance and the wrinkles from the usual daily activities can be removed easily.

4. **Drap-ability**

   Fabrics of nylon filament yarn have excellent draping qualities. The light weight sheer fabrics of nylon night gowns have high-draping quality. The medium-weight dress fabrics can drape very nicely.

5. **Heat Conductivity**

   The heat conductivity of the nylon fabrics vary depending upon the fabric construction, the type of nylon (staple/filament) used in the construction. In a closed or tight construction the air circulation through the fabric is limited. The heat and moisture of the body will not readily pass the fabric construction, which makes the wearer feel very warm. Such fabrics are good for winter apparel, such as wind-breakers, but are not suitable for summer garments.

6. **Absorbency**

   Nylon fabrics have low absorbency. The low absorbency of the fabrics tends to be advantageous and also disadvantageous. The main advantage of the nylons low absorbency is that the water remains on the surface of the fabrics and runs off the smooth fabric and hence dries quickly. This property makes the nylon fabrics suitable for raincoats and shower curtains. Nylon's low absorbency has a disadvantage in that the fabric feels clammy and uncomfortable in warm, humid weather.

7. **Cleanliness and Wash-ability**

   Nylon fabrics are easy care garments. Dirt doesn't cling to this smooth fiber, which can be washed easily or can be even cleaned by using a damp cloth. They easily pick up colour and dirt from the wash water. Nylons, washed with other fabrics pick up colour (even from the palest pastels) and develop a dingy grey appearance that is extremely difficult to remove. In addition to retaining their appearance during wear, garments made from nylon fabrics retain their appearance and shape after washing. Hot water should be avoided during washing as the hot water may cause wrinkling in some fabric constructions.

8. **Effect of Bleaches**

   The nylon fabrics are white and generally do not require bleaching. The nylon fabrics which pick up colour or develop grey should be bleached with oxidizing bleaches such as hydrogen peroxide.

9. **Shrinkage**

   Nylon fabrics retain their shape and appearance after washing. It has good stability and does not shrink.

10. **Effect of Heat**

    Nylon should always be ironed at low temperatures. Using hot iron will result in glazing and then melting of the fabric.

11. **Effect of Light**

    Nylon fabrics have low resistance to sun light. They are not suitable for curtains or draperies as it is weakened by the exposure to sun light.

12. **Resistance to Mildew**

    Nylon fabrics have absolute resistance to the development of mildew

13. **Resistance to Insects**

    Nylon is resistance to the moths and fungi.

14. **Reaction to Alkalis**

    Nylon has excellent resistance to alkali's but the frequent and prolonged exposures to alkalis will weaken the nylon fabrics.

15. **Reaction to Acids**

    Nylon is less resilient to the action of acids and is damaged by strong acids.

16. **Affinity for Dyes**

    Nylon can be easily dyed with a wider range of dyes. The dyed fabrics retain their colour and have good resistance to fading.

17. Resistance to Perspiration

Nylon fabrics are resistant to perspiration.

Nylon Blends

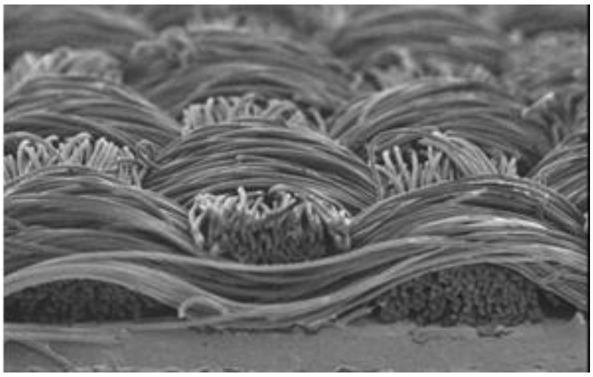
As pure nylon hosiery was sold in a wider market, problems became apparent. Nylon stockings were found to be fragile, in the sense that the thread often tended to unravel lengthwise, creating ‘runs’ People also reported that pure nylon textiles could be uncomfortable due to nylon's lack of absorbency. Moisture stayed inside the fabric near the skin under hot or moist conditions instead of being "wicked" away. Nylon fabric could also be itchy, and tended to cling and sometimes spark as a result of static electrical charge built up by friction. Also, under some conditions stockings could decompose turning back into nylon's original components of air, coal, and water. Scientists explained this as a result of air pollution, attributing it to London smog in 1952, as well as poor air quality in New York and Los Angeles.

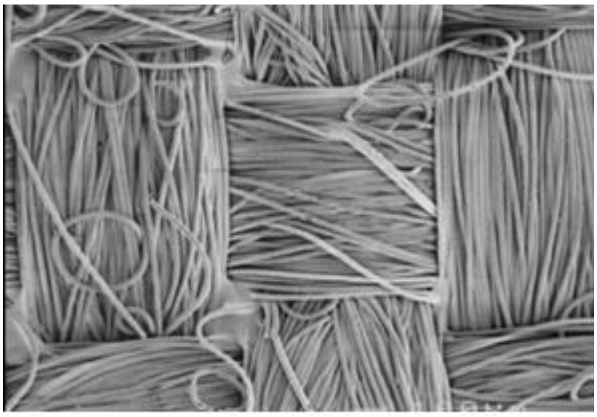
The solution found to problems with pure nylon fabric was to blend nylon with other existing fibers or polymers such as cotton**,** polyester**,** and spandex. This led to the development of a wide array of blended fabrics.

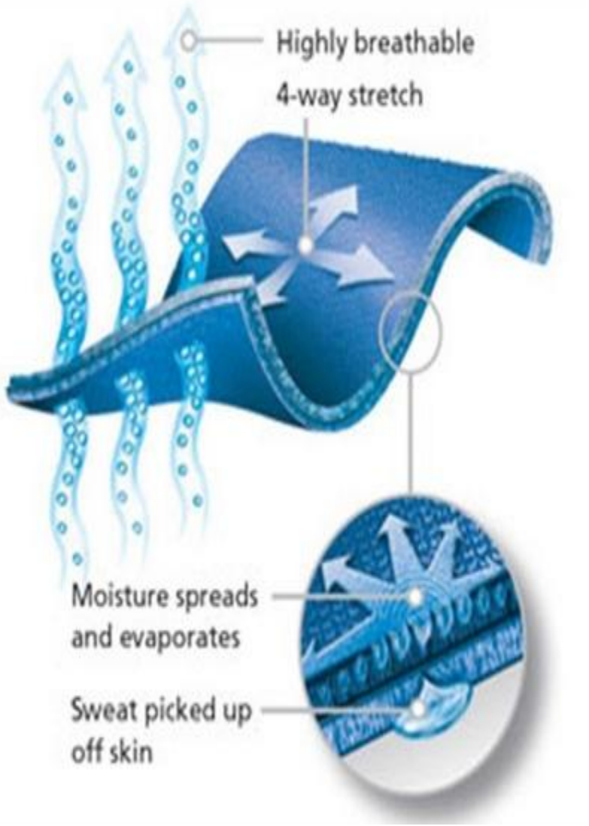
The new nylon blends retained the desirable properties of nylon (elasticity, durability, ability to be dyed) and kept clothes prices low and affordable.

CORDURA® Classic Fabric

Designed for living and built to last, the original durable CORDURA® fabric has proven performance in many of the world’s toughest environments. Made with high tenacity air jet textured nylon filament yarns in a range of sizes – 330D, 500D, 700D and 1000D, Woven – plain, dobby, basket and rip stop constructions. Can be finished, coated or laminated.







Originally developed and registered as a trademark by E.I. du Pont de Nemours and Company (DuPont) in 1929, it is now the property of INVISTA (a wholly owned subsidiary of Koch Industries).

Characteristics

1. Rugged - Excellent resistance to abrasion
2. Strong - Excellent tear strength
3. Water Repellent - Finished, coated and laminate options
4. Fiber - 100% high tenacity nylon filament fiber

Uses

The CORDURA® Classic fabric portfolio offers versatile solutions for a range of end-uses including footwear, bags, luggage and backpacks, military equipment, garment reinforcement and protective outerwear such as motorcycle clothing.

Features

1. Military-grade filament fiber
2. Excellent abrasion and tear resistance
3. Air jet textured for high abrasion resistance
4. Stylish versatility

Applications of Cordura Fabrics

1. Sports Wear
2. Eco Textiles
3. Military Clothing's
4. Fire Proof Fabrics
5. Smart Textile Fabrics
6. Motor Cycle Jackets
7. Other Smart Clothings

Advantages:

- Care And Cleaning
- Antibacterial And Antimicrobial
- Stain-resistant
- Pilling-resistance
- Wrinkle Resistance
- Moisture Wicking
- Flame/Fire Retardants

Acrylic Fiber

A manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of acrylonitrile units. Acrylic is lightweight, soft, and warm, with a wool-like feel. It can also be made to mimic other fibers.

Acrylic fibers are produced by two basic methods of spinning (extrusion), dry and wet. In the dry spinning method, continuous filaments which later may be cut into staple, if desired.

DuPont first made acrylic fibers in 1944 and trademarked them under the name "Orlon". Commercial production begin in 1950. It is spun by either dry spinning or wet spinning.

Acrylic is synthetic man-made fiber which was mimic created to mimic for wool and it does bear some resemblance to it in softness. The fiber has a soft, smooth feel which is very similar to wool and is light weight. It is often used to create plush vel Acrylic can be thought of as artificial wool.

Properties of Acrylic Fibers

1. **Length**

   The length of the acrylic fiber can be controlled. That means, it may be in filament or staple form.

2. **Fineness**

   Fineness of this fiber is also controllable. The filament yarns are made 75 to 200 denier ranges while staple fibers are made 2 and 3 denier cut into 1.5”, 2”, 3” and 4” length.

3. **Strength and Extension**

   It is fairly strong fiber. Its tenacity is 5 gm per denier in dry state and 4.8 gm per denier in wet state. Extension at break is 15%. Good recovery from deformation.

4. **Elasticity**

   It has an elastic recovery of 85% after 4% extension when the load is extremely released.

5. **Appearance**

   It is about 30% bulkier than wool. Regarding insulating warmth, it has about 20% greater insulating power than wool.

6. **Effects of Acid**

   It has good resistance to mineral acid.

7. **Effects of Alkali**

   The resistance to weak alkali is fairly good but hot strong alkali damages this fiber.

8. **Effects of Solvent**

   It has excellent resistance to common solvents, oils, greases, and natural salts.

9. **Effects of Water**

   Moisture regain of this fiber varies from 1.5% to 3%. Easy to wash and quick drying.

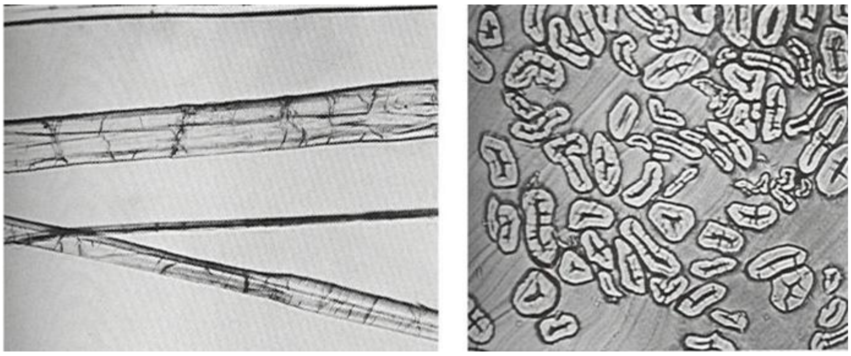
10. **Effect of heat and sunlight**

    This fiber has very good thermal stability. Safe ironing temperature is at 160^0C. At 230 – 235^0C acrylic sticks with the iron i.e. melting occurs. High temperature may sometime causes yellowing of this fiber.

11. **Effect of Biological agents**

    This fiber is unaffected by mildew, moulds, larves and insects.

12. **Microscopic view**



a. **Longitudinal View**

Smooth surface, uniform diameter, rod-like appearance, some types with irregularly spaced striations

b. **Cross-Sectional View**

Rounded or Dumbbell shaped

Characteristics of Acrylic Fiber

1. Luxurious appearance , Crisp or soft hand
2. Excellent drapeability and softness
3. Shrink, moth, and mildew resistant
4. Low moisture absorbency, relatively fast drying
5. No pilling problem, little static problem

Uses of Acrylic Fiber

1. Apparel - Sweaters, socks, fleece, circular knit apparel, sportswear, children's wear
2. Home Fashions - Blankets, throws, upholstery, awnings, outdoor furniture, rugs/floor coverings

Acrylic Blends

1. It is used as a blend component with cotton**,** viscose, wool etc.
2. It has good warmth and recovery property. It is also used for making carpet due to good resiliency property.

Textile Yarn

When there is more than one fiber interlocked, it is called yarn. A long continuous strand of interlocked or twisted fibres is yarn - which could be used for knitting, weaving, braiding, crocheting, embroidering, stitching, textiles etc.

Yarns play a vital role in the fabric manufacturing process. Yarn is a product of substantial length and relatively small cross-section consisting of **fibers** or filaments with or without twist. It is the long fine structures capable of being assembled or interlaced into such textile products as woven and knitted fabrics, braids, ropes, and cords.

Classification of Yarns

1. **Single yarn**

   It is the simplest continuous strand of fiber. Spun yarn or filament yarn is single yarn.

2. **Fly yarn**

   Fly yarn is produced by twisting two or more single yarn together. It is also called folded yarn.

3. **Cabled yarn**

   Cabled yarn is produced by twisting two or more ply or folded yarns. Example-cords

4. **Core spun yarn**

   It is a special type of yarn. Core spun yarn is formed by wrapping with staple fiber a continuous filament core.

5. **Fancy or novelty yarn**

   A **fancy yarn** can be defined as one that differs from the normal construction of a single or doubled yarn by deliberately introduced irregularities in its construction.

6. **Stretch yarn**

   Stretch yarns are synthetic yarns that are very tightly twisted, heat-set, and then untwisted, producing a spiral crimp giving a springy character. Generally 87% Cotton, 13% Polyester is used to make stretch yarn.

Yarn Designation

The factor which are required to express yarn structure and properties wholly, are called yarn designation. Main features are :-

1. Yarn Count / Linear Density.
2. No. of Filaments.
3. Fiber Components.
4. No. of components in folding.
5. Direction & amount of twist.

The Yarn Manufacturing Process

There are three major spinning processes: cotton, worsted or long-staple, or wool. Synthetic staple fibers can be made with any of these processes. Since more yarn is produced with the cotton process than the other two, its manufacture is described below.

1. **Preparing the Fibers**

   Fibers are shipped in bales, which are opened by hand or machine. Natural fibers may require cleaning, whereas synthetic fibers only require separating. The picker loosens and separates the lumps of fiber and also cleans the fiber if necessary. Blending of different staple fibers may be required for certain applications. Blending may be done during formation of the lap, during carding, or during drawing out. Quantities of each fiber are measured carefully and their proportions are consistently maintained.

2. **Carding**

   The carding machine is set with hundreds of fine wires that separate the fibers and pull them into somewhat parallel form. A thin web of fiber is formed, and as it moves along, it passes through a funnel-shaped device that produces a ropelike strand of parallel fibers. Blending can take place by joining laps of different fibers.

3. **Combing**

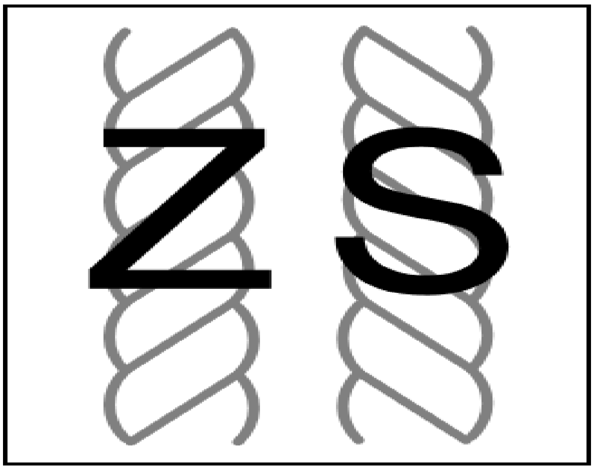
   When a smoother, finer yarn is required, fibers are subjected to a further paralleling method. A comb like device arranges fibers into parallel form, with short fibers falling out of the strand.

4. **Drawing out**

   After carding or combing, the fiber mass is referred to as the sliver. Several slivers are combined before this process. A series of rollers rotating at different rates of speed elongate the sliver into a single more uniform strand that is given a small amount of twist and fed into large cans. Carded slivers are drawn twice after carding. Combed slivers are drawn once before combing and twice more after combing.

5. **Twisting**

   The sliver is fed through a machine called the roving frame, where the strands of fiber are further elongated and given additional twist. These strands are called the roving. Twisting, in yarn and rope production, process that binds fibers or yarns together in a continuous strand, accomplished in spinning or playing operations. The direction of the twist may be to the right, described as Z twist, or to the left, described as S twist.



Single yarn is formed by twisting fibers or filaments in one direction.

Ply yarn is made by twisting two or more single yarns together, usually by combining singles twisted in one direction with a ply twist in the opposite direction.

Cable twist twine, cord, or rope can be made with a cable twist, each twist in the opposite direction of the preceding twist (S/Z/S or Z/S/Z), or with a hawser twist,

The single yarns and the first ply twist in one direction and the second ply twist in the opposite direction (S/S/Z or Z/Z/S). The number of turns per unit of length in a yarn affects the appearance and durability of fabric made from that yarn. Yarns used for soft-surfaced fabrics have less twist than those used for smooth-surfaced fabrics. Yarns made into crepe fabrics have maximum twist.

6. Spinning

a. Ring Spinning

The predominant commercial systems of yarn formation are ring spinning and **open-end spinning**. In ring spinning, the roving is fed from the spool through rollers. These rollers elongate the roving, which passes through the eyelet, moving down and through the traveler. The traveler moves freely around the stationary ring at 4,000 to 12,000 revolutions per minute. The spindle turns the bobbin at a constant speed. This turning of the bobbin and the movement of the traveler twists and winds the yarn in one operation.

b. Open end Spinning

Open-end spinning omits the roving step. Instead, a sliver of fibers is fed into the spinner by a stream of air. The sliver is delivered to a rotary beater that separates the fibers into a thin stream that is carried into the rotor by a current of air through a tube or duct and is deposited in a V-shaped groove along the sides of the rotor. As the rotor turns, twist is produced. A constant stream of new fibers enters the rotor, is distributed in the groove, and is removed at the end of the formed yarn.

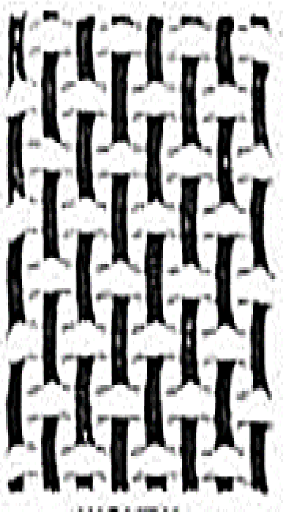
Textile Fabric

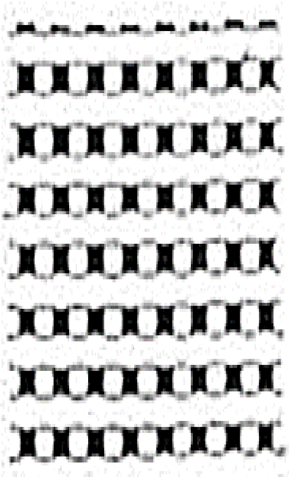
Textile fabrics are planar structures produced by interlacing or entangling yarns or fibers in some manner. There are three basic steps required for fabric production. The first step in creating fabric is yarn production.

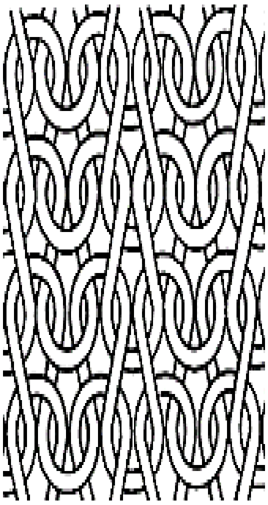
After the fabric has been woven or knitted, removed from the manufacturing machines and is ready for the final step: processing. Woven Fabric that's fresh off the loom is called greige, and it looks nothing like the crisp white sheets or clothing you're used to. It's discolored and full of impurities, seed particles and debris. Before it can be transformed into useful textiles, it must be cleaned. First, it's treated with bleach to purify the base color. Next, it's treated with a variety of chemicals and cleaners to remove oils, wax and other elements that are naturally occurring in most fibers. Finally, it's ready to be shipped out to clothing and textile manufacturers.

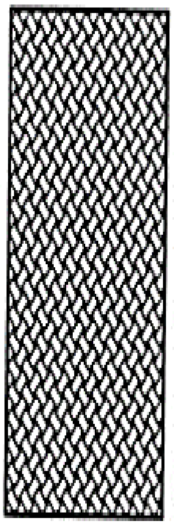
Following are the type of the fabric used.

1.	**Woven**	A planar structure produced by interlacing yarns, fibers or filaments.
2.	**Knitted**	A structure produced by interloping one or more ends of yarn.
3.	**Braided**	A structure produced by interlacing several ends of yarn in a manner such that the paths of yarn are not parallel to the fabric axis (laces)
4.	**Felted/ Non Woven**	A structure consisting of a web of fibers held together with a cementing medium which does not form a continuous sheet of adhesive material (felt)


Woven


Nonwoven


Knit


Braid

Manufacturing Process

1. **Spinning**

   The process of making yarns from the textile fiber is called spinning. Spinning is the twisting together of drawn out strands of fibers to form yarn, though it is colloquially used to describe the process of drawing out, inserting the twist, and winding onto bobbins.

2. **Weaving**

   Weaving is textile craft in which an interlacement of two sets of yarns or threads (warp or end and weft or the filling) at right angle to make a fabric, with the help of machine called loom, which has necessary arrangement for this purpose

Pre-Treatment Process

1. **Singeing**

   Singeing is a process applied to both yarns and fabrics to produce an even surface by burning off projecting fibers, yarn ends, and fuzz. This is accomplished by passing the fiber or yarn over a gas flame or heated copper plates

2. **De-sizing**

   De-sizing is the process of removing the size material from warp yarns after a textile fabric **is** woven

3. **Scouring**

   Scouring process bears an impotency in wet processing. Scouring is the process by which natural (oil, wax, gum, fat etc) as well as added (during fabrication process) impurities are removed completely as possible

4. **Bleaching**

   All raw textile materials, when they are in natural form, are known as 'greige' material. This greige material will have its natural color, odor and impurities that are not suitable for clothing materials. The removal of these natural coloring matters and add-ons during the previous state of manufacturing is called bleaching.

5. **Mercerizing**

   Mercerization is a textile finishing treatment or cellulose fabric and

   yarn, mainly cotton and flax, which improves dye uptake and tear strength, reduces fabric shrinkage, and imparts a silk-like luster.

6. **Dyeing and Finishing Process.**

   a. Dyeing in textiles is a process in which color is transferred to a finished textile or textile material (like fibers and yarns) to add permanent and long-lasting color. It can be done by hand or by machine

   b. Finishing refers to the processes that convert the woven or knitted cloth into a usable material and more specifically to any process performed after dyeing the yarn or fabric to improve the look, performance, or "hand" (feel) of the finish textile or clothing. The precise meaning depends on context.

Chapter – 2

Woven Textile

Weaving has its roots in basket making. Man has learned to weave as early as the new stone age from the fibers of the flax plant, he had learned to weave linen cloth .As soon as people discovered how to create fabric they figured one way to cross the different threads to make beautiful patterns.

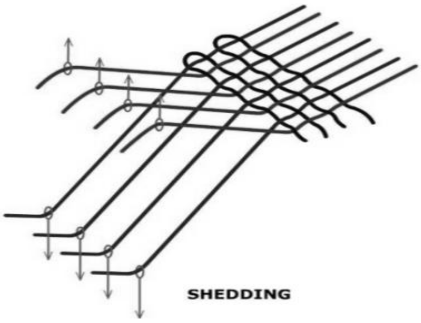
"Weaving is textile craft in which an interlacement of two sets of yarns or threads (warp or end and weft or the filling) at right angle to make a fabric", with the help of machine called loom, which has necessary arrangement for this purpose

Weaving Process

In any type of weaving, four operations are fundamental, performed in a sequence and are constantly repeated:

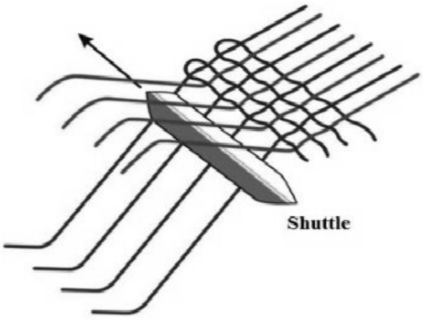
1. **Shedding**:

   Raising specific warp yarn by means of the harness or heddle frame.



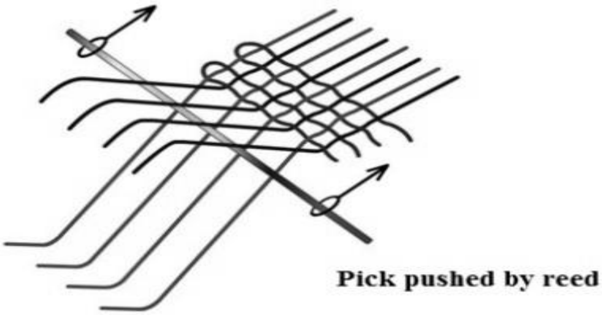
2. **Picking :**

   Inserting filling yarns through the shed.



3. **Beating Up:**

   Pushing filling yarns firmly in place by means of the reed.



4. **Taking up and letting off**:

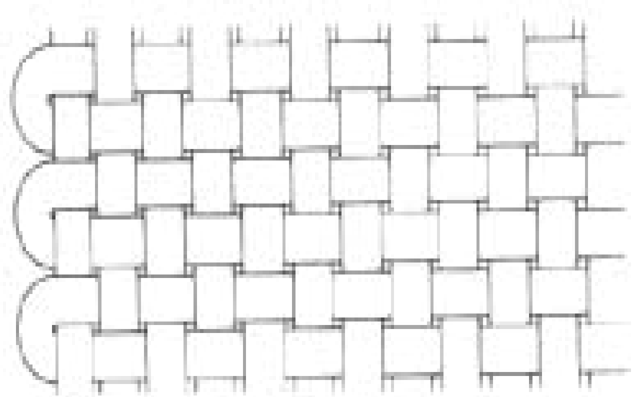
   Winding the finished tab of the cloth beam releasing more of the warp from the warp beam.

Classification of weave:

Insertion of filling yarn determines the pattern of weave; weave pattern produce, appearance durability, and drape. Following are three basic weave in common use for the majority of fabrics.

1. **Plain weave**.

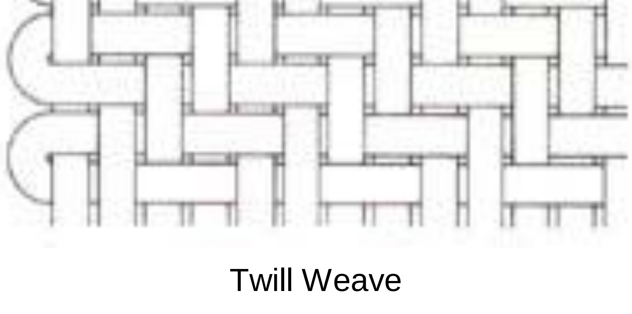
   It is the simplest type of construction, Each filling yarn goes alternately under and over the warp yarns across the width of fabric .If the yarn are close together the plain weave has a high thread count and the fabric is therefore firm and will accordingly wear well. Plain weave is relatively inexpensive it is used extensively for cotton fabrics and for fabric that are to be decorated with printed design, appearance vary by using different count and number of thread, normally flat no distinct design unless yarns have contrasting colours or thickness. There is wide variety of fabrics made of the plain weave from the light weight to thicker heavy weight.



Plain Weave

2. **Twill Weave**.

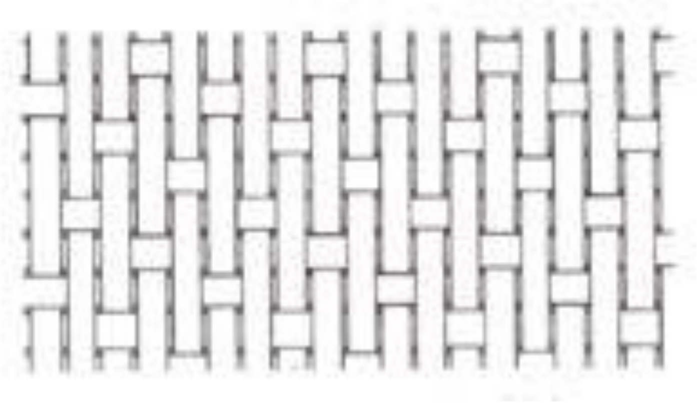
   Second basic weave, called the twill weave. The values of twill weave included its strength and drape ability, Twill fabrics are frequently more tightly woven and will not get dirty as quickly as plain weave, twill are more difficult to clean. Twill weave are therefore commonly used in men’s suit and coat fabrics and for work clothes where strong construction is essential, majority of fabrics in twill weave are medium weight.



Twill Weave

3. Satin Weave

Satin weave is similar to twill weave but it differs in appearance because diagonal of satin weave is not visible there is no visible design on the face of the fabric.



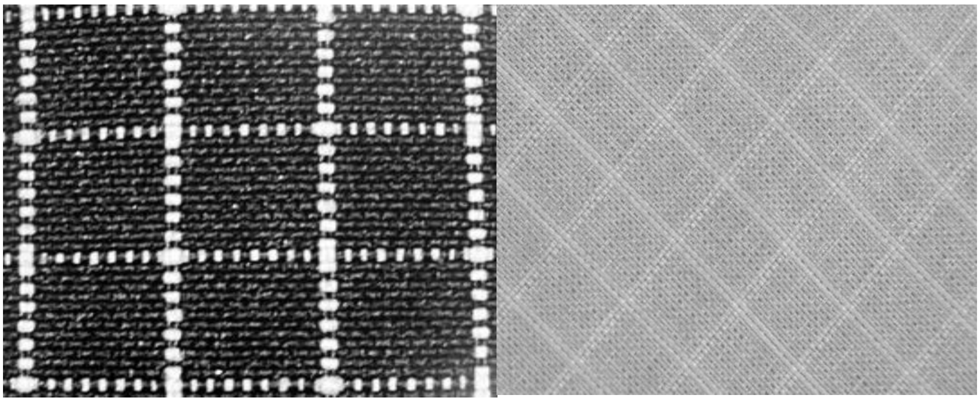
Satin Weave

4. Ripstop weave

Ripstop fabrics are woven fabrics, using a special reinforcing technique that makes them resistant to tearing and break. During weaving, (thick) reinforcement threads are interwoven at regular intervals in a crosshatch pattern. A similar effect can be achieved by weaving two or three fine yarns together at smaller intervals.

Advantages of rip stop are the favorable strength-to-weight ratio and that small tears can not easily spread. Fibers used to

make rip stop include cotton, silk, polyester and polypropylene**,** with nylon content limited to the crosshatched threads that make it tear-resistant.



Weaving Defects

In the course of making fabrics, weaving defect may occurs due to faulty yarn, weaving machine malfunction or improper finishing of fabric. Defects are calcified as major and minor defects.

Major and Minor Defects.

If the defects are in a small area affecting appearance only without affecting serviceability / durability these are known as **minor defects** other wise the same will be treated **as major defects**.

In short, in weaving if one warp or weft thread is disturbed affecting appearance only it will be considered as minor defect, if the same is more than one affecting serviceability / durability and also appearance then it will be treated as major defect. Two minor defects are treated as one major defect.

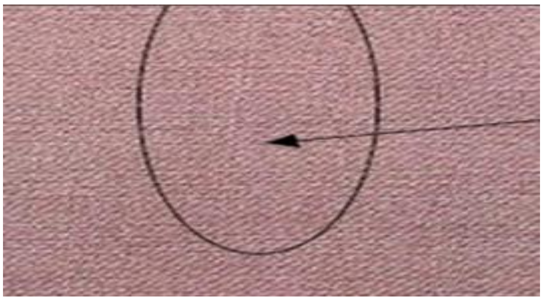
Defects In Woven Fabric

Some of the common defects that can appear in woven fabric that can hamper the quality of garment produced out of it, are as follows:-

Weft Direction Defects

Mixed End/ Thick End

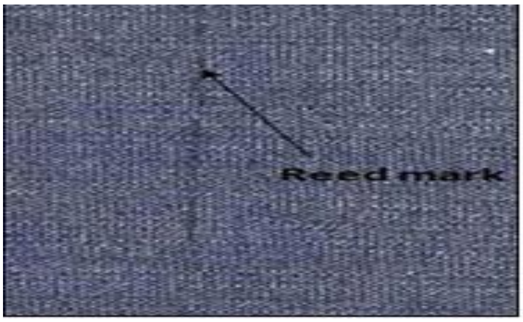
It can be identified as the warp end having larger diameter than the other warps



Warp Direction Defects

Reedy Fabric Marks

Appearance of fine cracks across the fabric between warp end groups which resemble denting pattern in the reed. Due to high warp tension

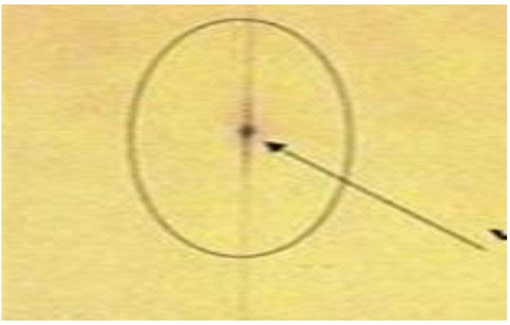


Warp Streaks

Warp streaks can be identified as the warp way stripes of shade variations occurring between groups of threads

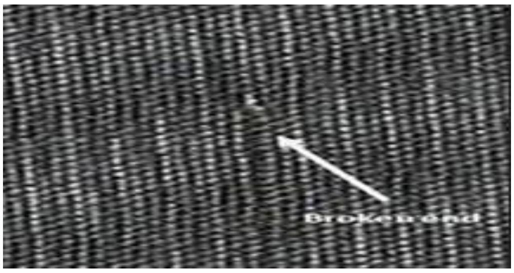
Misdraws / Wrong Draw

Design or stripes in the final fabric being damaged due to drawing of incorrect ends.



Broken / Missing End

It can be identified as the space created in the fabric when a yarn partially or completely is missing from the fabric



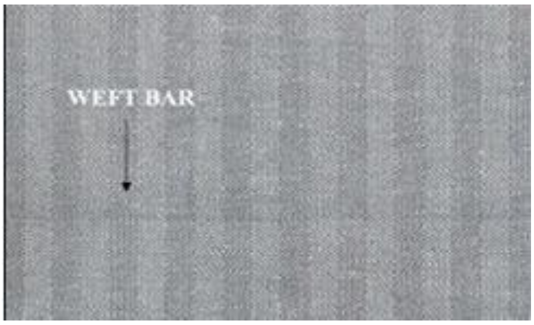
Weft Direction Defects

Starting Marks:

Thick or thin places occurring in fabric due to pick density variation when starting the loom, causing starting marks.

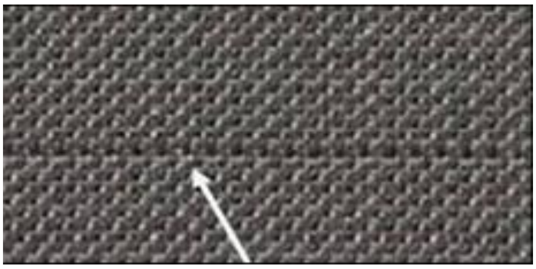
Filling/Weft Bars

It is a band running weft-wise across the full width of the cloth count difference in weft, excessive tension in the weft



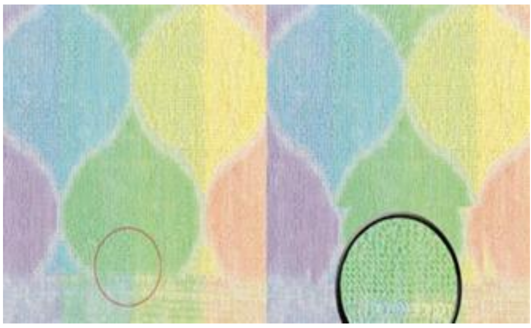
Broken Pick

Broken Pick defect can be identified as the weft inserted to only a partial portion of the pick.



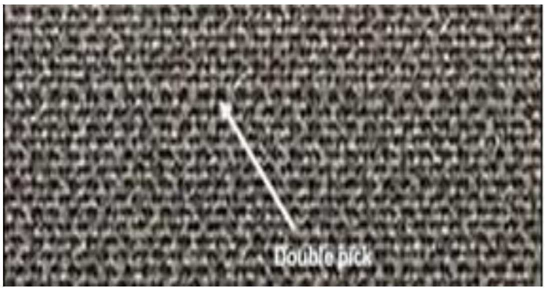
Broken Pattern

The sequence of weft yarn colour breaks or pattern width of particular colour is distorted, broken pattern defect appears.



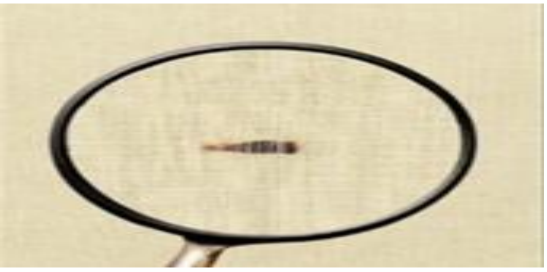
Double Pick

This defect happens when more than one pick is inserted in the single shed.



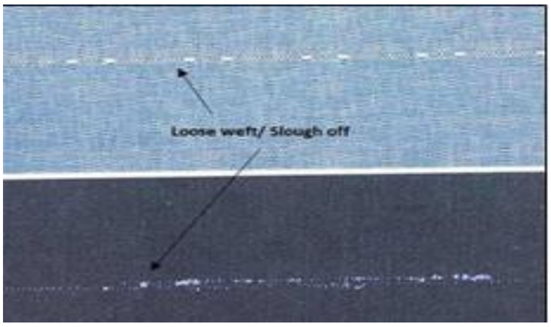
Gout

Appearance of foreign matter or contamination like lint, waste, etc woven into the fabric.



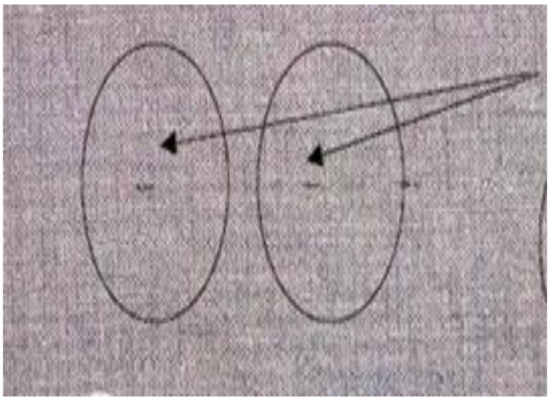
Sloughing off

When a bunch of or coil of yarn slips from the pirn during weaving then thick yarn bunches or coils appear on the fabric.



Snarl

When yarn doubles back on itself especially because of high twist yarn, then snarling appears. It can be found randomly spread across fabric width or only in a region nearby the selvedge.



In these descriptions of “defects” and the items “appearance” “noticeable” etc, refer to examination at three meters distance in good normal illumination.

Chapter – 3
Knitted Textile

Hand knitting was an early invention. The earliest known knitted fabric was a pair of thick, hand-knitted wool socks found in an Egyptian tomb, which probably dated back to the fourth century B.C.

“ It is process in which fabrics are produced by interlocking one or more or by forming loops. It involves the use of one or more yarn moving in one direction.

Introduction

Knitting is the second most frequently used method of fabric construction. The popularity of knitting has grown tremendously within recent years because of the increased versatility of techniques, the adaptability of the many new manmade fibers and the growth in consumer demand for wrinkle-resistant, stretchable, snug-fitting fabrics, particularly in the greatly expanding areas of sportswear and other casual wearing apparel.

Today, the usage of knitted fabrics ranges from hosiery, underwear, sweaters, slacks, suits and coats, to rugs and other home furnishings.

Knitting is a complex industry, which has two main areas, each of which has its subdivisions of specializations. One area produces knitted good for apparel manufacturers, for sewing centers for consumers.

Comparison of Knitting with Weaving

Woven fabrics are constructed by the interlacing of two or more sets of yarns, which does not allow the fabric to stretch to any marked degree unless it is especially stretch-woven. If a certain amount of stretching is necessary, woven fabric must be cut on the bias – that is, in a diagonal direction. Even then the fabric can be stretched only in the direction of the diagonal cutting. The advantage of stretch-ability in knitted fabrics is an important consideration where fit and comfort are concerned – they fit the figure but do not bind it.

Knitted fabrics also give warmth because of the isolative air pockets contained in this type of construction. Yet they are porous and provide “breathing” comfort because body movements cause the loops to expand and contact, thus pushing air through close fitting garments. However, unless the fabric is heavily napped or foam laminated, it is not windproof.

Knitting Properties

Knitted fabrics are very absorbent, light in weight, and wrinkle-resistant. It is usually unnecessary to iron them after packing and laundering.

Knitted Construction

Knitted fabrics may be constructed with a single yarn that is formed into interlocking loops by the use of hooked needles. The loops may be either loosely or closely constructed, according to the purpose of the fabric. Crocheting is knitting in its simplest form. A chain of loops is produced from a single thread by means of a hook. The interlocking loops of the knitted construction permits the fabric to stretch in any direction, even if low-grade yarn having little elasticity or yarn that lacks natural elasticity is used.

It will be recalled that thread count (the number of threads per square inch, or cm) is used to evaluate the construction of woven fabrics. The construction of knitted fabrics is evaluated by the number of stitches or loops. When the interlocking loops run lengthwise, each row is called a **Wale**. A wale corresponds to the direction of the warp in woven fabrics. When the loops run across the fabric, each row is called a **Course**. A course corresponds to the filling or weft. Thus, a knitted fabric having 40 loops or stitches in 1 inch of width, and 50 loops in 1 inch of length, is said to have 40 wales and 50 courses. In metric terms, a knitted fabric having 16 / cm loops or stitches across the width and 20 / cm loops in the length is said to have 16 wales and 20 courses.

All other factors of yarn and knit type being equal, the fabric that has more Wales in it will be more rigid and stable in width but the fabric with more courses in it will be more rigid and stable in length. The fabric that has both more wales and more courses per area will also have better recovery from stretching than one with fewer wales and courses per area, whereas, the fabric with less wales and courses prepare will be less rigid, stretch more easily, fit to the body contour better, but have poorer recovery ability. Also, the fabric that has more wales will shrink less in the width, while the fabric that has more courses in it will shrink less in the length.

The quality of the needles will affect the quality of the knitted fabric. If the thickness of the hook varies from one needle to the next, the stitches will vary in width. Also, if the needles vary in length, so will the loops. Obviously, these variations will affect the appearance, texture, and performance of the knitted fabric.

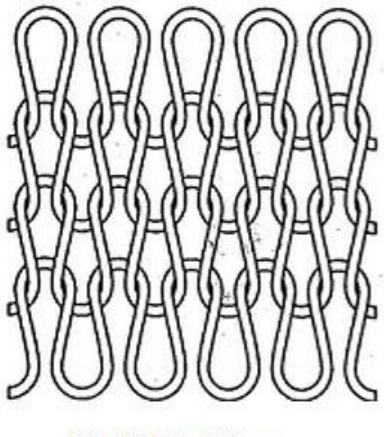
Some constructions, such as jersey and rib knitting, are made with a latch needle, which has a latch or swinging finger that closes onto the hook of the needles as it pulls the yarn through a loop to form a new loop. Other knits, such as the tricot, Milanese and simples, are made with a springy-bead needle that has a fine, springy hook which slightly resembles a beard. This type of hook must be used with a sinker to hold the fabric down and presser to close the hook as it forms the loop. However, because of its fineness, the spring-beard needle can be used in the knitting machine is much closer formation to produce more finely constructed fabrics with smaller loops.

Classification of Knitted Fabric

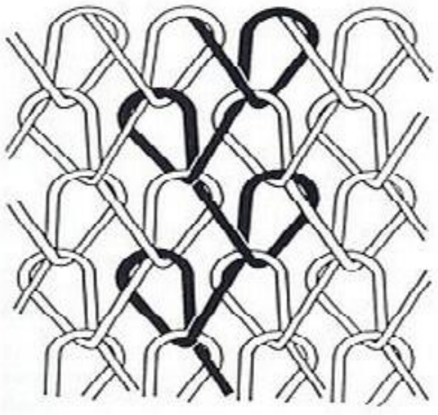
Knitted fabrics are divided into two general types

1. Those produced by weft knitting, where one continuous yarn form courses across the fabric.

2. Those produced by warp knitting, where a series of yarns forms wales in the length wise direction of the fabric.



Weft Knitting



Warp Knitting

Difference between Warp Knitting and Weft Knitting

Warp knitting	**Weft knitting**
Yarn runs in horizontal direction	Yarn runs in the vertical direction
Elastic to the length	Elastic to the width
Less shrinkage	Higher shrinkage
Perfect for dry wash.	Perfect for hand wash.
Loops are produced to the length of fabric.	Loops are produced to the width of fabric.
At least one yarn is required for each knitting needle.	Number of knitting needle is required for one yarn.
Yarns are supplied from the beam.	Yarns are supplied from the cone.

Knitting Process

In this process, the stitch is made when a loop of yarn or thread is drawn through a previously made loop. Such loops are made horizontally across the fabric and the fabric can be made with a single yarn or thread. The system is carried out with help of hook type needles called “Weft Knitting” because the thread passes across the fabric.

Another system of knitting is to supply at least one thread to every needle and the ends run down the fabric. This is called “Warp Knitting”. A row of loops across is termed a “Course” and row of loops down a “Wale”. The number of wales per inch gives the indication of needles per inch and the number of courses per inch indicates the length of stitches. Following are the machines commonly used in knitting.

1. Straight bar machine.
2. Circular machine.
3. Flat bar machine.
4. Warp knitting machine.

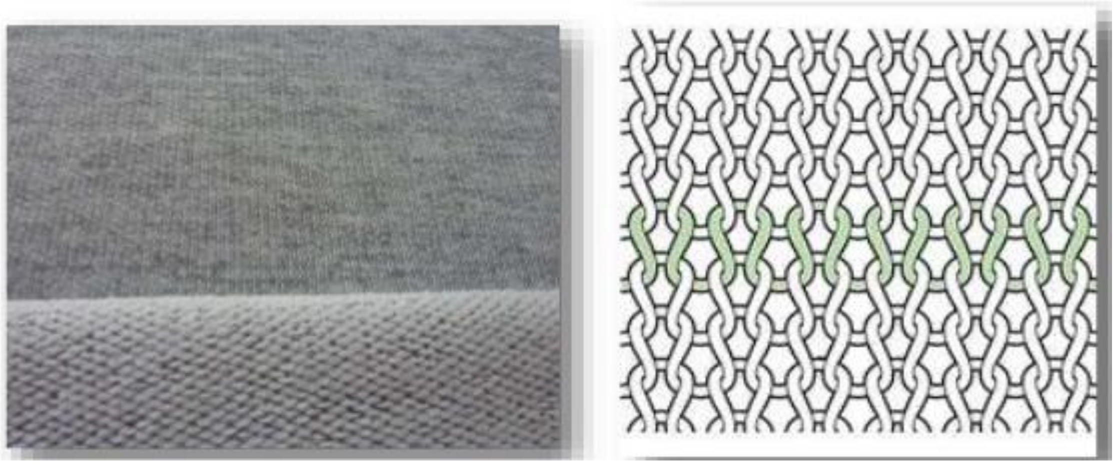
Flat bed Knitting Machine

Circular Knitting Machine

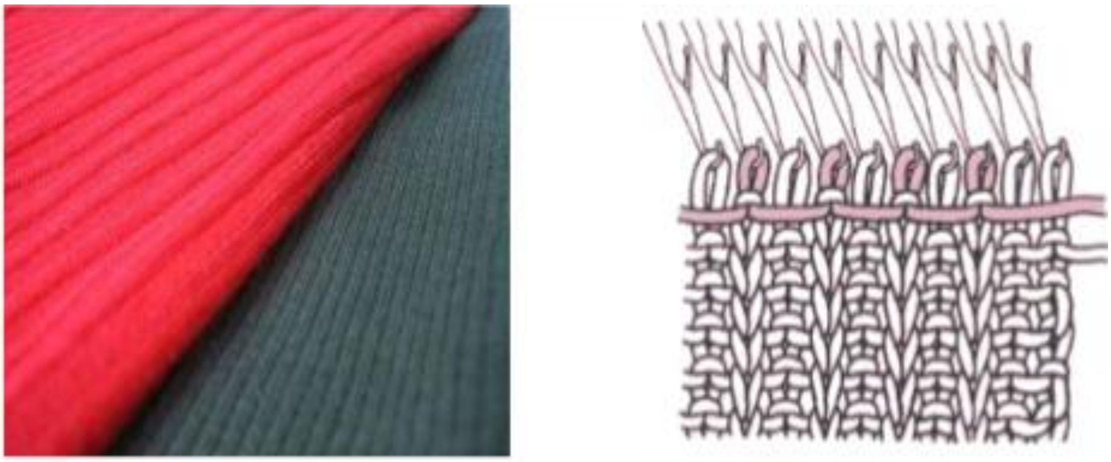
Types of Knitting

Following types of knitting are commonly used:-

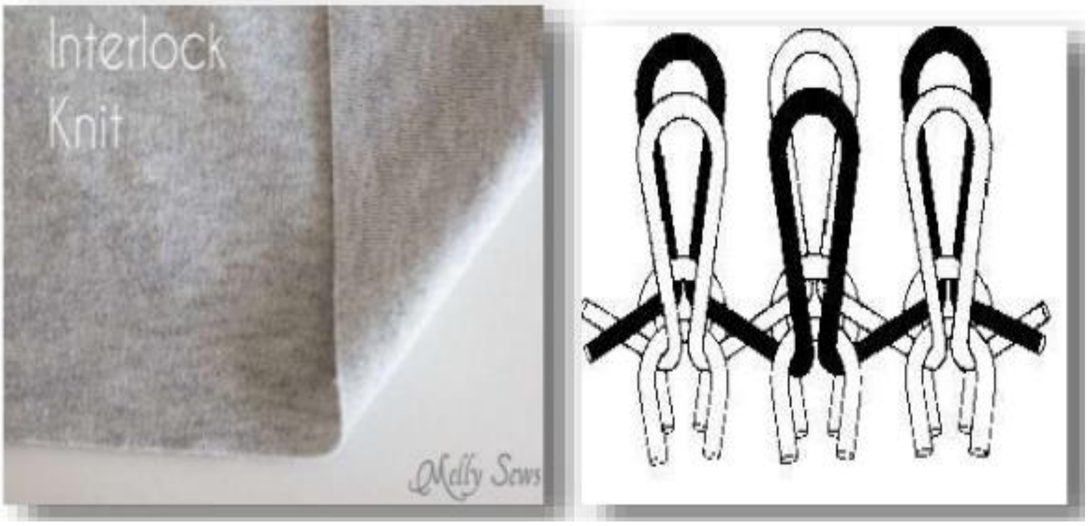
1. Plain knitting.
2. Rib structure knitting.
3. Interlock knitting.



Single Jersey



Rib Stitch



Interlock Stitch

Chapter – 4

Braided Textile

Braiding is a simple form of narrow fabric construction. It is done by intertwining of yarns in whatever direction suited the maker's purpose. This began as a handicraft for the construction of decorative fabrics but the limitations of knitting and weaving made braiding an important method of fabric formation in textile composite manufacturing industry.

Lace making, a domestic art of seventh century, is the beginning of narrow fabric production. Increasing need for tapes in electrical uses, ribbons and laces made this handicraft into a leading industry. The manual efforts were replaced by narrow width looms. There are definite trends towards knitting by the crochet methods in some areas of narrow fabric production. For foundation wear, the trend is towards lighter-weight sheer garments so that the bindings should also be light weight, while, at the same time, fashion trends have dictated that a variety of coloured yarns be incorporated in these bindings. Crochet knitting machines have been found ideal for this purpose and have replaced large numbers of traditional braiding machines.

Types of Braiding

Braiding can be classified as two and three-dimensional braiding. Two-dimensional braid structure can be circular or flat braid. Three-dimensional braiding is relatively new and was developed mainly for composite structures..

a. Two Dimensional Braiding

Two-dimensional circular or flat braid is formed by crossing a number of yarns diagonally so that each yarn passes alternately over and under one or more of the others. The most common designs in two-dimensional braids are as follows:

(1) Diamond braids: 1/1 intersection repeat.

(2) Regular braids: 2/2intersection repeat.

(3) Hercules braids: 3/3intersection repeat.

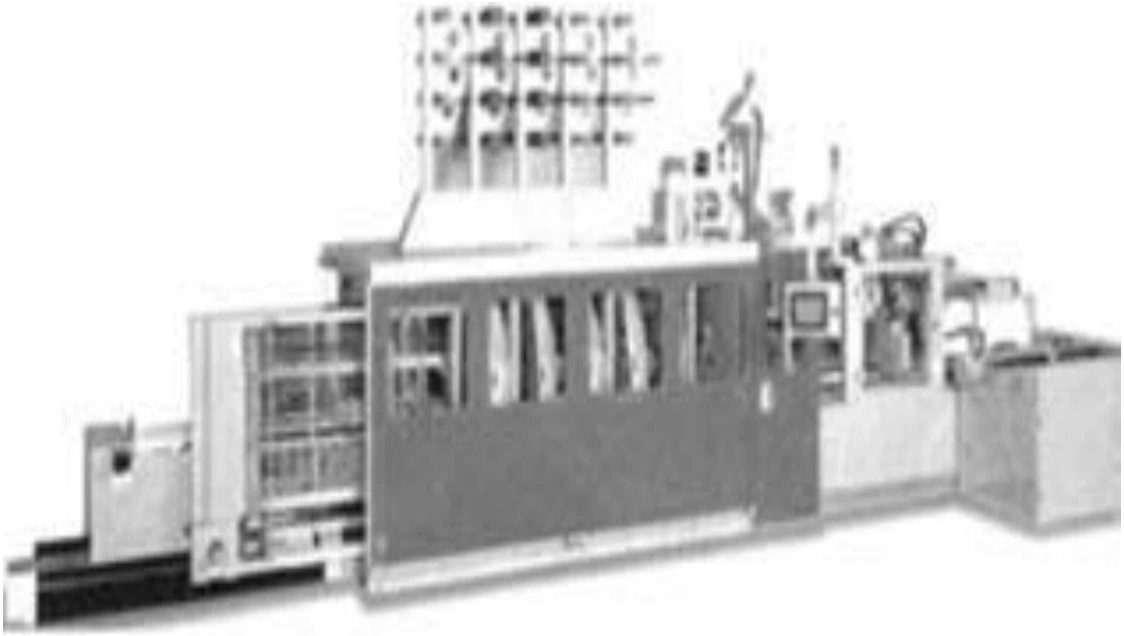
b. Three Dimensional Braiding

Three-dimensional braids are formed on two basic types of machines. These are the horn gear and Cartesian machines, which differ only in their method of yarn carrier displacement

c. Circular Braiding

Circular (tubular or round) braids are formed hollow or around a centre core. A circular braiding machine consists of two sets of an even number of spools containing the braiding yarns. One set runs clockwise around the centre of the machine and the other set turn in counterclockwise direction. While revolving in opposite directions, the carriers are diverted to pass alternately inside and outside (under and over) one another. The clockwise and counterclockwise paths cause the two sets of yarns to intersect, thus producing a tubular braid.

The yarns from the yarns are collected above the hub of the circular track in which the bobbins travel. Circular braiders are called as "Maypole Braiders" since their motion is similar to the maypole dance.



Shoelaces

Shoelaces, also called shoestrings (US English) or bootlaces (UK English), are a system commonly used to secure shoes**,** boots, and other footwear**.** They typically consist of a pair of strings or cords, one for each shoe, finished off at both ends with stiff sections, known as aglets. Each shoelace typically passes through a series of holes, eyelets, loops or hooks on either side of the shoe. Loosening the lacing allows the shoe to open wide enough for the foot to be inserted or removed. Tightening the lacing and tying off the ends secures the foot within the shoe. Shoe laces are of two type flat shoe lace or round shoe lace

Braided Nets

In textiles, ancient method of constructing open fabrics by the crossing of cords, threads, yarns, or ropes so that their intersections are knotted or looped, forming a geometrically shaped mesh, or open space.

Modern **net** fabrics are produced not only by the netting method but also by **weaving**, **knitting**, and crocheting and are usually machine-made. The meshes vary greatly in shape and size, and weights range from fine to coarse.

Braided Ropes

These ropes come in many variations and braiding patterns, but always consist of bundles of fiber which are formed into strands and then woven together by passing each strand over and under the others.

Ropes most important properties are the tensile properties like breaking force and elongation, but the elasticity and the bending rigidity too. There are several investigations about the influence of the braiding angle over the mechanical properties of the ropes based on analytical relations between the geometry of the yarns in one braid and the properties of the braid.

Types of Ropes

1. **Diamond Braid**

   These ropes are formed by rotating half the yarn strands in one direction on the braider, while the other half rotate in the opposite direction. These cords may be hollow, or they may have a center core of parallel fibers. These ropes tend to be a little flatter than other braided rope constructions.

2. **Double Braid**

   These ropes are constructed from an inner hollow single braided rope (core) which has another hollow single braided rope constructed around its exterior (skin). The end result is a rope within a rope. Both the skin and the core share the load on the rope, but not necessarily in equal amounts. These ropes are generally very flexible, strong and pleasant to handle. They are easily spliced. Caution must be exercised where double braid ropes are run over pulleys, through hardware, or in any situation where the outer rope may slide along on the inner rope and bunch up. This condition, often called “milking”, will result in a dramatic loss of strength by causing the entire load to be applied to the inner core. These ropes are also referred to as “Marine Ropes”, “Yacht Braid” and “2 in 1”.

3. **Kernmantle**

   These ropes are made by braiding a cover (mantle) over a core (kern). The core may consist of filaments of fiber lying essentially parallel inside the rope, or it may be twisted or braided into little bundles. The ropes are designed so that the inner core is taking most (often all) of the load, with the outer cover serving mainly to protect against abrasive action, dirt, and UV rays. All other types of rope have the load bearing fibers exposed and therefore deteriorate more rapidly. These ropes are exceptionally strong and durable, and can be made to have very low elongation. All kernmantle ropes have some stretch. However, static ropes are designed to minimize the amount of stretch, whereas dynamic ropes have relatively more stretch.

4. **Solid Braid**

   These ropes are made by braiding 12, 18 or 20 strands in a reasonably complex pattern with all the strands rotating in the same direction on the braider. The center of the rope may contain a filler core. These ropes maintain their round shape and therefore work very well in pulleys and sheaves. They tend to have high elongation but generally have less strength than other constructions. They cannot be spliced. These ropes are also referred to as “Sash Braid”.

Narrow fabric

Narrow fabrics, sometimes referred to as 'small wares' are any textile fabric not exceeding 4 cm in width with 2 selvedges. Thus, narrow fabrics include any trimming, elastic, tape, ribbon, lace, cording and more.

Ribbons, tapes and webbings are all considered as woven narrow fabrics if they contain woven selvedges, and are less than 12 inches. They are woven on special narrow fabric looms, using the basic principle of warp filling interlacing. Several sets of warp yarns may be beamed together to make several narrow fabrics side by side, on the same loom. Some tapes and ribbons are prepared by cutting the full width fabrics into strips and sealing the edges. Thermoplastic fabrics can be woven of this way.

Chapter – 5

Felted & Non Woven Textile

Felt is a textile material that is produced by matting, condensing and pressing fibers together. Felt can be made of natural fibers such as wool or animal fur, or from synthetic fibers i.e petroleum based acrylic or wood pulp-based rayon.

Blended fibers are also common depending on its intended use. Adding a percentage of synthetic fibers can increase felts durability for certain crafts or industrial use, and can also increase pliability.

A common fiber sometimes added to wool is rayon, which when added removes the prickly feeling that pure wool can often have against the skin. Meaning that a synthetic mix is the best of both worlds! It can take a large amount of work, but the result is a very dense fabric consisting of permanently interlocked fibers.

The process of creating felt can be pretty labour intensive, involving various steps of blending the fibers, matting the material, shrinking and steam-pressing. However, the most straight forward method is simply to apply heat and moisture which causes the mix of fibers to merge and blend together. You can even do this yourself at home to any wool or knitted products pop it in the washing machine for a process known as ‘felting’ or ‘filling’

Types of Felt

There are a few types of felt readily available to work with

1. **Pressed felt**

   This is the oldest form of felt (or fabric at all) that is known to man, it even predates knitting and weaving techniques. It’s the most common type, which uses wool fibers or a blend of wool and synthetic fibers which are compressed using heat and moisture, causing the fabrics to interlock. It can be cheap to make, and can also be made in a range of thicknesses which achieve a high density.

2. **Needled Felt**

   In the case of needed felt, a blend of wool and synthetic fibers, or 100% wool, are again interlocked but this time by a machine rather than naturally. Machines that contain thousands of needles interlock the fibers to produce this softer, less dense type of felt fabric which is often used for crafts or cushioning.

3. **Woven Felt**

   To make woven felt, wool or a wool blend is directly woven into a cloth and then moisture and pressure are applied. This makes the fibers naturally interlock, as with pressed felt. This incredibly durable fabric is ideal for musical instruments and door seals, and has a much lower maximum thickness than needled or pressed felt.

Uses

Felt has a *huge* range of uses, depending on the type you're using and the quality of the wool. Wool has different textures ranging from silky to coarse, which ultimately effects the felt you create with it.

Felt has an incredibly unique texture and qualities, and can be made from a wide range of materials which is quite unusual in a fabric. Needled felt is very soft making it perfect for crafts, whereas wool blends are light and breathable but still keep you toasty during the Winter months; making them perfect for knitwear.

Pure wool felt is a natural insulator and very resilient to wear and tear, as well as being strong and able to absorb moisture. This means it can be used for home furnishings as well as decorative items.

Nonwoven fabric

Nonwoven fabrics are actually not fabrics as they have no internal structure as such it is a fabric-like material made from staple fiber (short) and long fibers (continuous long), bonded together by chemical, mechanical, heat or solvent treatment.

Some nonwoven materials lack sufficient strength unless reinforced by a backing. They are flat or tufted porous sheets that are made directly from separate fibers, molten plastic or plastic film. Nonwovens a more ecological fabric for certain applications, especially in fields and industries where disposable or single use products are important, such as hospitals, schools, nursing homes and luxury accommodations.

Nonwoven fabrics are engineered fabrics that may be single-use, have a limited life, or be very durable. Nonwoven fabrics provide specific functions such as absorbency, liquid repellence, resilience, stretch, softness, strength, flame retardancy, washability, cushioning, thermal insulation, filtration, use as a bacterial barrier and sterility. These properties are often combined to create fabrics suited for specific jobs. They can mimic the appearance, texture and strength of a woven fabric and can be as bulky as the thickest puddings. In combination with other materials they provide a spectrum of products with diverse properties, and are used alone or as components of apparel, home furnishings, health care, engineering, industrial and consumer goods. Non-woven materials are used in numerous applications, including:

1. Medical
2. Filters
3. Geo textile

Chapter – 6
Dying of Textile

The various finishing process suggested additional means of enhancing the appearance of the newly formed fabric. It means that dyeing process to provide lasting beauty and diligent to one beholder by adding colour to fabrics. In dyeing process, fiber yarn, or fabric is impregnated with dyestuff.

To select the proper dye for fiber, it is necessary to know which dyes have an affinity for the vegetable, animal or man-made.

Dyes have their own limitations, one of these is the fastness of color. Fastness of colour refers to its ability to remain unchanged. Different dyes of different colour have different degrees of fastness to various conditions. Fastness to various condition mean

1. Colour fastness to washing
2. Colour fastness to perspiration
3. Colour fastness to rubbing
4. Colour fastness to light
5. Colour fastness to dry cleaning

Some dyes may bleed when wet and may causes discoloration when wet or when washed with other fabrics. They lose their colour.

Selection of dye is very important to its use for example Tent needs dye, which has quality of dye fastness to light because they must stand strong light daily but do not need to be washed frequently. Fastness of washing is important to dress fabrics because they must undergo frequent washing. Therefore, both the kind of fiber / fabrics is dyed the intended use for the fabric should be considered.

When two or more fabrics are dyed particularly by different dyes. The colour / shade may appear to mater in one light (day light).

Dye is divided in two groups as following:-

1. **Natural Dyes**

Natural dyes are obtained from flower, nuts, vegetable source, animal and mineral sources.

2. **Synthetic Dyes**

Synthetic dyes were first derived from cooltar, synthetic dyes may be categorized into sixteen classes.

Classification of Dyes Following dyes are commonly used.

a. Basic Dyes
b. Acid Dyes
c. Mordant or Chrome Dyes.
d. Direct Dyes
e. Azoic Dyes.
f. Disperse Dyes.
g. Sulphur Dyes.
h. Vat Dyes.
i. Reactive Dyes.
j. Pigment Dyes.
k. Disperse Dyes

a. **Vat Dyes**

Vat dyes are the fastest dye for cotton, linen, and rayon. These also may be applied to some other fabrics / fibers with the use of mordant, these dyes are not only resistance to light, acid and oxidation properties.

b. **Pigment Dyes**

Pigment dyes are used in the form of paste on a pattern or a design in one or more colour. Actually, they are not real dyes because they have no affinity for the fiber and are applied and held to fabric with resin, which are then cured at high temperatures.

Dyeing Methods

There are many ways to dye textile materials. In most dyeing processes, water is used with the dye and other additives to affix color to textiles. When the textile is rinsed, the color stays. A dye may also be pressed into a fabric through a thick paste, or the textile material may be immersed into a dye vat or tub.

Colour is applied to fabric by different methods of dyeing for different types of fiber and at different stages of the textile production process. Dyeing can be done during any stage in the textile manufacturing process. Textiles may be dyed as fibre, as yarn, as fabric, as garments, depending upon the type of the fabric or garment being produced.

a. **Direct Dyeing**

When a dye is applied directly to the fabric without the aid of an affixing agent, it is called direct dyeing. In this method the dyestuff is either fermented (for natural dye) or chemically reduced (for synthetic vat and sulfur dyes) before being applied. The direct dyes, which are largely used for dyeing cotton, are water soluble and can be applied directly to the fiber from an aqueous solution. Most other classes of synthetic dye, other than vat and sulfur dyes, are also applied in this way.

b. **Stock Dyeing**

Stock dyeing refers to the dyeing of the fibers, or stock, before it is spun in to yarn. It is done by putting loose, unspun fibres in to large vats containing the dye bath, which is then heated to the appropriate temperature required for the dye application and dyeing process.

Stock dyeing is usually suitable for woolen materials when heather like color effects are desired. Wool fibre dyed black, for example, might be blended and spun with un-dyed (white) wool fibre to produce soft heather like shade of grey yarn.

Tweed fabrics with heather like color effects such as Harris Tweed are examples of stock dyed material. Other examples include heather like colours in covert and woolen cheviot.

c. **Top Dyeing**

Top dyeing is also the dyeing of the fibre before it is spun in to yarn and serves the same purpose as stock dyeing – that is, to produce soft, heather like color effects. The term top refers to the fibres of wool from which the short fibres have been removed. Top is thus selecting long fibres that are used to spin worsted yarn. The top in the form of sliver is dyed and then blended with other colors of dyed top to produce desired heather shades.

d. **Yarn Dyeing**

Yarn dyeing is the dyeing of the yarns before they have been woven or knitted into fabrics. Yarn dyeing is used to create interesting checks, stripes and plaids with different-colored yarns in the weaving process. In yarn dyeing, dyestuff penetrates the fibers in the core of the yarn. There are many forms of yarn dyeing

(1) **Skein (Hank) Dyeing**

Skein dyeing consists of immersing large, loosely wound hanks (skeins) of yarn into dye vats that are especially designed for this purpose. Soft, lofty yarns, such as hand knitted yarns are usually skein dyed. Skein dyeing is the most costly yarn-dye method.

(2) **Package Dyeing**

In package dyeing the yarn is wound on a small perforated spool or tube called a package. Many spools fit into the dyeing machine in which the flow of the dye bath alternates from the center to the outside, and then from the outside to the center of the package. Package dyed yarns do not retain the softness and loftiness that skein-dyed yarns do. They are however satisfactory and very widely used for most types of yarns that are found in knitted and woven fabrics.

(3) **Warp Beam Dyeing**

Beam dyeing is the much larger version of package dyeing. An entire warp beam is wound on to a perforated cylinder, which is then placed in the beam dyeing machine, where the flow of the dye bath alternate as in the package dyeing. Beam dyeing is more economical than skein or package dyeing, but it is only used in the manufacture of woven fabrics where an entire warp beam is dyed. Knitted fabrics, which are mostly produced from the cones of the yarn, are not adaptable to beam dyeing.

e. **Piece Dyeing**

The dyeing of cloth after it is being woven or knitted is known as piece dyeing. It is the most common method of dyeing used. The various methods used for this type of dyeing include jet dyeing. Jig dyeing, pad dyeing and beam dyeing.

f. **Garment Dyeing**

Garment dyeing is the dyeing of the completed garments. The types of apparel that can be dyed are mostly non-tailored and simpler forms, such as sweaters, sweatshirts, T-shirts, hosiery, and pantyhose. The effect on sizing, thread, zippers, trims and snaps must be considered. Tailored items, such as suits or dresses, cannot be dyed as garments because the difference in shrinkage of the various components and linings disort and misshape the article. Garment dyeing is done by placing a suitable number of garments (usually about 24 sweaters or the equivalent, depending on the weight) into large nylon net bag. The garments are loosely packed. From 10 to 50 of the bags are placed in large tubs containing the dye bath and kept agitated by a motor – driven paddle in the dye tub. The machine is appropriately called a paddle dryer.

Direct dyeing and Yarn Dyeing methods are the most popular ones

Dyeing Defects

Dyeing defects occur due to dyeing process. They are due to fabric construction, faulty preparation of the fabric before dyeing, poor dye selection or improper dyeing procedures. Some dyeing defects are as follow:

1.	Barrer	A horizontal shaded band running across the width of the fabric
2.	Blending	Loss of colour when dyed fabric is wetted or in water.
3.	Crocking	Rubbing off of colour. It may stain onto another fabric.
4.	Off shade	Colour that does not exactly match the standard.
5.	Shade bar	A horizontal band of different has scrutiny across the fabric.
6.	Shading	Variation in colour tones.
7.	Stained.	Fabric indicates a discoloration.
8.	Streaked.	Fabric indicates either a stain or uneven dyeing.

Chapter – 7

Printing of Textile

When the fabric passes through finishing operation it may be given lustrous effects that contribute further to its final appearance.

One form of applying colour decoration to a fabric after it has been otherwise been finished is called printing. Fabric to be printed must be singed, bleach and clean. There are three basic approaches to printing a colour on a fabric.

1. **Direct**

   The most common approach for applying a colour pattern is direct printing the dye is imprinted in the fabric in paste form, these are called pigment print.

2. **Discharge**

   Another approach for applying a colour pattern is discharge printing. The fabric is dyed and then printed with chemicals that will destroy the colour in design area.

3. **Resist**

   A third approach to obtain a colour pattern is resist printing. A resin substance that cannot be penetrated when the fabric is subsequently immersed in a dye .The dye will affect only the parts that are not covered by resist paste. After dying resin paste is removed leaving a pattern on dark ground.

Each of the above approaches is used on one or more methods of application described as under:

1. **Block Printing**

   It is one of the oldest and simplest method of making colour design on the textile. Print design is made on the wooden block. Printing paste is placed in a suitable pad and wooden block press on the printing paste and then press on the fabric. After the first printing succeeding impressions is made on the fabric.

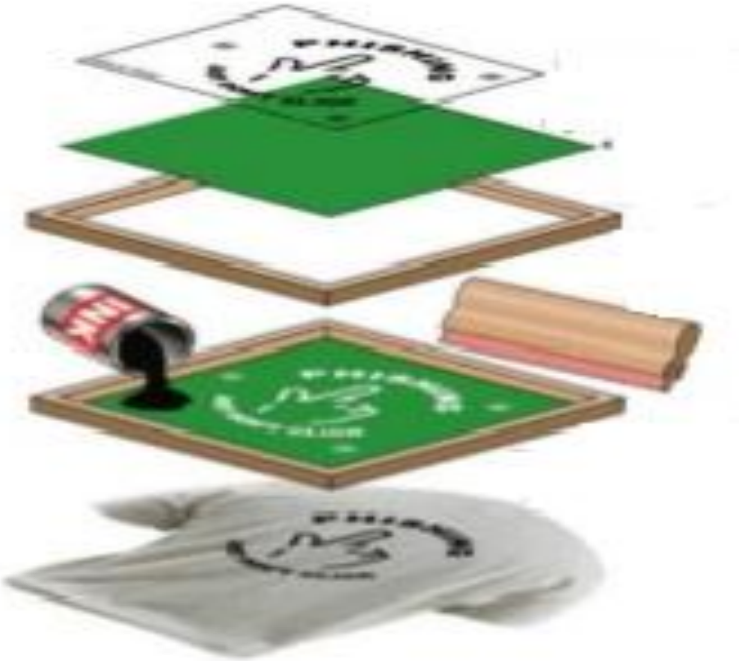
2. **Roller Printing**

   Roller printing is the machine method of printing designs on cloth by engraved rollers. It turns out color-designed fabrics in vast quantities at the rate of 1000 to 4000 yards an hours. This method of producing attractive designs is relatively inexpensive when compared with any hand method. It is a machine counterpart of block printing. The printed cloth is immediately passed into a drying chamber and then into a steam chamber where the moisture and heat sets the dye.

3. Stencil or Screen Printing

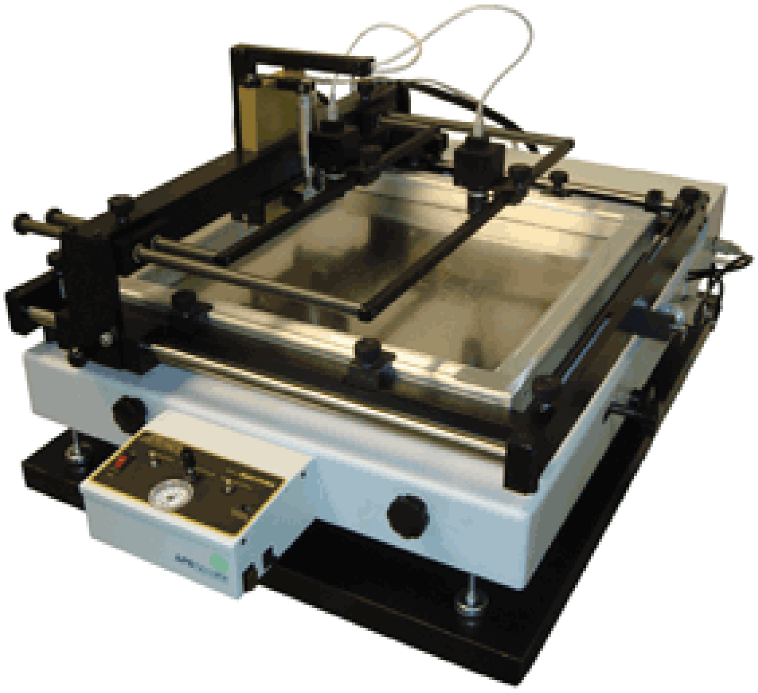
a. Screen Printing Process By Hand.

This is one of the oldest /advanced methods of printing textile; fabrics screen printings are less expensive. A wooden frame having fine silk or nylon cloth fixes on one of its side forms the screen. The designs are made on the screen by blocking out unwanted portions with un-soluble lacquer or resin. A rubber blade called squeezer is drawn across its face so that the print paste is transferred to the cloth. The screen is lifted moved by a distance equal to the width of the design re-laid and the action repeated for the length of table. After the impression with one colour is made the cloth is dried and 2nd colour is in the required pattern is applied. Similarly the designs are completed with other colours.



b. Screen Printing Process By Machine

These days screen printing has been made a continuous operation with the help of suitable machines in which the fabric is moved to the length of a repeat the screen lowered the printing action taken the screen lifted and then cloth moved to the next position.



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Chapter – 8

Finishes of Textile

Textile Finishing is a process used in manufacturing of fiber, fabric, or clothing. In order to impart the required functional properties to the fiber or fabric is to make more acceptable in a highly competitive market. It contributes either to an increased aesthetic value where the senses of sight sound and touch are involved or to increase utility where measurable qualities of strength. it is customary to subject the material to different type of physical and chemical treatments

Types of Finishes: Following are three types of finishes for fabrics

1. **Non-Durable Finishes**

   Non-durable finishes are mainly cheaper and early to apply. These types of finishes are applied only those fabrics which do not required washing as they are not fast to wash.

2. **Semi Durable Finishes**

   These types of finishes are applied only those fabrics which do not need frequent washing as these types of washing stands for maximum 15 washes

3. **Durable Finishes**

   These types of finishes are permanent finishes having fast to repeated washing applied only those fabrics which required frequent washing

Common Finishes of Textile

1. **Mercerization**

   Mercerizing is an important preparatory process for cotton fabric. Mercerizing causes the flat, twisted, Ribbon like cotton fiber to swell into a round shape and to contract in length.

   This is a physico-chemical process and consists in treating cotton material with 20-25% solution of caustic soda. Under tension or without tension to allow for free shrinkage. The caustic soda is subsequently washed off and residual alkali is neutralized. Mercerizing process alters the properties of cotton materials and brings the following changes.

   a. Increase in luster.
   b. Increased tensile strength.
   c. Increase in hygroscopicity
   d. Increase in dye up-take.
   e. Increase in chemical reactivity.
      (1) Higher extension at break
      (2) Preferential absorption of caustic soda

   Mercerization Process

   Both yarn and cloth can be mercerized, yarn used for sewing knitting and embroidery is generally mercerized before dyeing whereas cloth receives this treatment for specific uses. The stage of cloth mercerization may be grey, scoured and bleached depending upon the circumstances and nature of subsequent processing. While mercerizing cloth to get high degree of luster, the following factors must be kept in view:-

1. Longer the staple, better the luster.
2. Lesser the twist in yarn, higher the luster.
3. Weave Effect: The satin weave get better luster than plain weave

The material is sheared and singed properly before mercerizing the cloth can be mercerized in grey condition, but better results are attained by mercerizing the scoured cloth and then followed by bleaching. The following conditions are essential for proper mercerization.

2. **Sanforizing**

Sanforizing is controlled compressive shrinkage process, which is applied on woven fabric to achieve shrinkage before making the garments. The fabric is run through a sanforizer; a machine that has drums filled with hot steam. The fabric is given an optimum dimensional stability by applying mechanic forces and water vapour

After sanforizing the residual shrinkage of woven fabric may be zero. In sanforizing process shrinkage is achieve by passing the cotton fabric onto a movable elastic felt blanket is released it assumes a shortened conditional. Thus the cotton fabric is forced to conform this compression.

3. **Calendaring**

A process of passing cloth between rollers (or "calendars"), usually under carefully controlled heat and pressure, to produce a variety of surface textures or effects in fabric such as compact, smooth, supple, flat and glazed. During calendaring, the yarns in the fabric are squashed into a flattened elliptical shape; the intersections are made to close-up between the yarns. This causes the fabric surface to become flat and compact. The improved plainness of surface in turn improves the glaze of the fabric. The calendar machines may have several rollers, some of which can be heated and varied in speed, so that in addition to pressure a polishing action can be exerted to increase lustre.

4. **Raising or Napping**

The raising of the fiber on the face of the goods by means of teasels or rollers covered with card clothing (steel wires) that are about one inch in height. Action by either method raises the protruding fibers and causes the finished fabric to provide greater warmth to the wearer, makes the cloth more compact, causes the fabric to become softer in hand or smoother in feel, increase durability and covers the minute areas between the interlacings of the warp and the filling. Napped fabrics include blankets, flannel, unfinished worsted, and several types of coatings and some dress goods. Other names for napping are Gigging, Genapping, Teaseled, Raised.

5. **Softening**

Softening is carried out when the softness characteristics of a certain fabric must be improved, always carefully considering the composition and properties of the substrate.

6. **Crease Resistant Finish**

Crease Resistant Finishes are applied to cellulose fibers (cotton, linen and rayon) that wrinkle easily. Permanent Press fabrics have crease resistant finishes that resist wrinkling and also help to maintain creases and pleats throughout wearing and cleaning.

7. **Peach Finish**

   Subjecting the fabric (either cotton or its synthetic blends) to emery wheels, makes the surface velvet like. This is a special finish mostly used in garments.

8. **Anti Pilling Finish**

   Pills are masses of tangled fibers that appear on fabric surfaces during wear or laundering. Fabrics with pills have an unsightly appearance and an unpleasant handle. Loose fibers are pulled from yarns and are formed into spherical balls by the frictional forces of abrasion. These balls of tangled fibers are held to the fabric surface by longer fibers called anchor fibers.

   Anti pilling finish reduces the forming of pills on fabrics and knitted products made from yarns with a synthetic-fiber content, which are inclined to pilling by their considerable strength, flexibility and resistance to impact.

9. **Water Proof Finish**

   Waterproof Finishes -Allows no water to penetrate, but tend to be uncomfortable because they trap moisture next to the body. Recently, fabrics have been developed that are waterproof, yet are also breathable

10. **Antibacterial Finish**

   The inherent properties of textile fibers provide room for the growth of micro-organisms. The structure and chemical process may induce the growth, but it is the humid and warm environment that aggravates the problem further. Antimicrobial finish is applied to textile materials with a view to protect the wearer and textile substrate itself.

   Antimicrobial finish provides the various benefits of controlling the infestation by microbes, protect textiles from staining, discoloration, and quality deterioration and prevents the odor formation. The application of the finish is now extended to textiles used for outdoor, healthcare sector, sports and leisure.

Special Finishes

To maintain the fabrics in their original form and to impart desirable properties special finishes are used. These finishes are created to meet the needs and demands of processors and finishers as well as those of consumers. Some are created to make the newer synthetics available in fabrics with consumer appeal while others are made to maintain and existing marker for some of the natural fibers. Some of the finishes are as under:

1. **Wash & Wear Finish**

   Durable finish is latest and easy care fabric finish. The durable or wash & wear is applicable to finishes which have undergone significant pressing at a temperature of 300 to 375 ^{o}F and a pressure of 0.6 – 1 kg /cm ^{2}. It causes a garment to keep it shape-retaining properties throughout its life. The Shape retaining characteristics include:

   a. Smooth wrinkle free appearance

   b. Good creases and pleat retention after repeated wearing and washing

   It was the cotton fabrics which were treated for durable press finish, due to decrease strength and processing problems the trend now a days is towards the blends which include polyester and cotton, Nylon and cotton and polyester and Acrylic.

2. **Fire Retardant Finish**
    a. This finish is mainly used for Cotton fabric. These finishes are in all three types such as non-durable, semi durable and durable finish as per requirement of fabric usage.
    b. Non durable fire retardant finishes are mainly cheaper and early to apply; fabrics dip in the chemical & dry the fabric. These types of finishes are applied only those fabrics who do not required washing.
    c. Semi durable having combination of chemicals and temperature and fabric was padded with chemicals and cure at high temperature and specified time. The disadvantage of these type of finishes is that they have loss the fire retardant properties with alkali or when washed with soap and losses the 10-15 % of its strength.
    d. Durable finishes are required to be fast to washing or cleaning and which should not produce any undesirable effect on the fabric properties. These types of finishes are permanent finishes one of the permanent finishes is coating.
3. **Water Repellent Finish**

    Water repellent finishes are on the fabric does not allow the water to pass through but permit to pass air. There are many types of chemical used for these types of finishes following are mainly used.

    a. Aluminum Compound
    b. Silicones

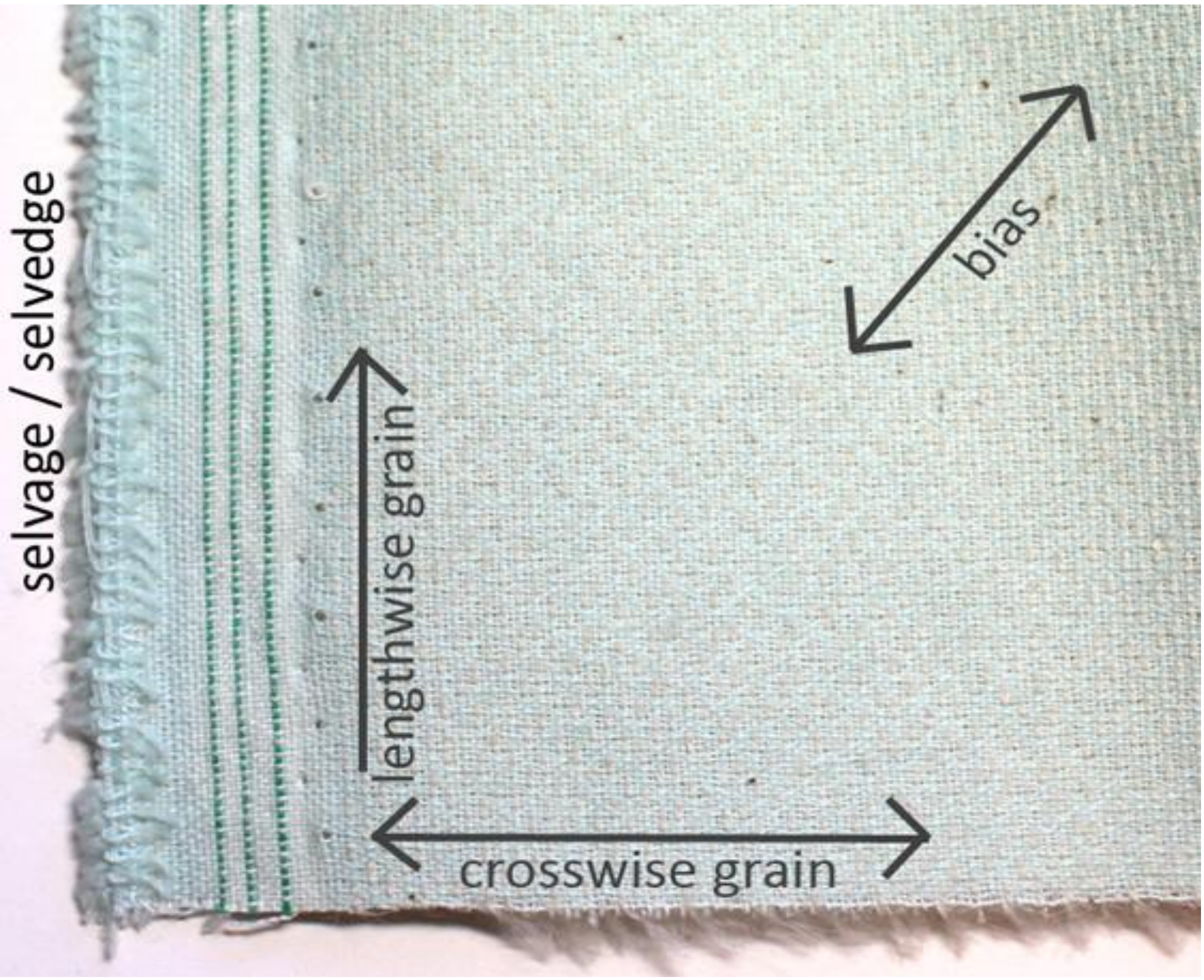
Sewing Thread Finishing

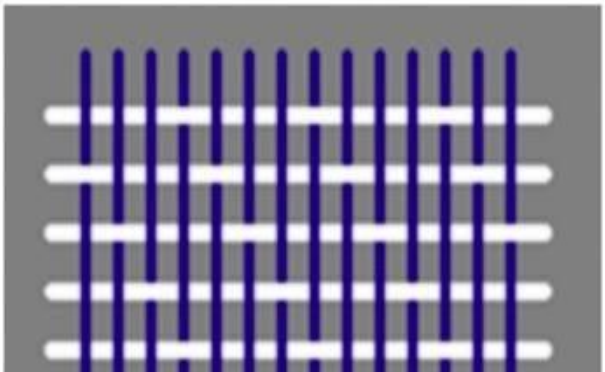
Apart from many of the above said finishes which can be applied to sewing threads also, A variety of finishes are used to improve the sew-ability of sewing thread.

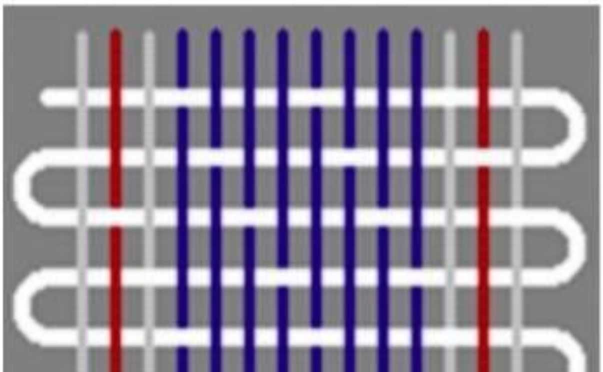
1. Lubricants reduce friction and improve the lubricity of the thread. Lubricity refers to the frictional characteristics of thread as it passes through the sewing machine and into the seam. Good lubricity characteristics will minimize thread breakage and enhance sew-ability.
2. Glazing increases strength and abrasion resistance.Glaze Finish refers to a finish put on 100% cotton threads or cotton-polyester core spun thread made from starches, waxes or other additives. This coating is then brushed to give the thread a smooth surface. A glaze finish protects the thread during sewing giving better ply security and abrasion resistance.
3. Bonding to increase strength and surface smoothness. Bonded Finish refers to a finish applied to continuous filament nylon and polyester threads which coats the fibers, giving the thread better ply security and abrasion resistance.

Chapter – 9

Selvedge







The narrow edge of woven fabric that runs parallel to the warp. It is often made with stronger yarns, or in a tighter spacing, to prevent raveling. The warp way strip which form's the edge of a piece of cloth is known as selvedge. As the shuttle move back and forth across the width of the shed, it weaves a self-edge called the selvage. The selvedge prevents the fabric from raveling. It is usually made more compact and stronger than the rest of the fabric by using more or heavier warp yarn or by using a stronger weave. There are different kinds of selvages. The kind of selvage used depends upon economy of production and the expected use of the fabric. It serves the following purposes :-

1. To bind at least one of the extreme ends with the weft for preventing fraying of the cloth.
2. To provide extra strength in the edge's where the cloth is held by clips in the subsequent finishing process**.**
3. To provide end capable of withstanding of greater abrasion by the reed occurring at the edges of the warp.
4. To provide space for ornamentation as in saree / dhoti.

According to the interlacing or the type of loom these are classified into two types namely

a. Conventional Selvedge

It is formed because the shuttle contains enough weft for several picks ,and picking motion is arranged in both the side of the loom.

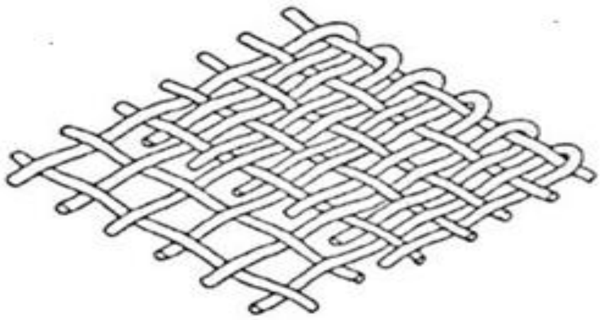
b. **Unconventional Selvedge**

It is employed in the conventional loom like rapier, air jet, projectile weaving, as the picking mechanism is arranged only at one side of the loom .

Three kinds of selvedges can be formed

1. **Tucked in selvedge:-**

A special hooked needle driven by a cam produces, after cutting the insertion of the producing thread end into the subsequent shed, thus forming a strong edge.



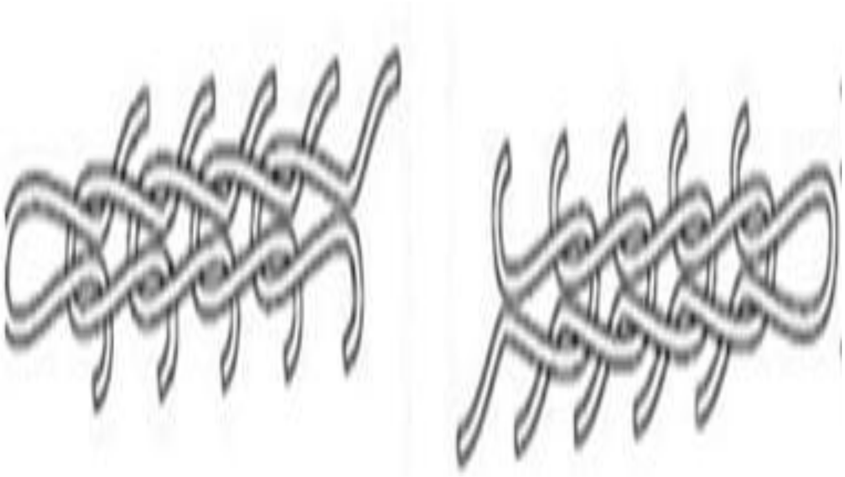
Tucked in selvedge

2. **Fused Selvedge:-**

These are obtained by pressing hot mechanical elements on the fabric edge. Sometimes used to split the wider fabrics into narrow fabrics.

3. **Chain Stitch Selvedge**

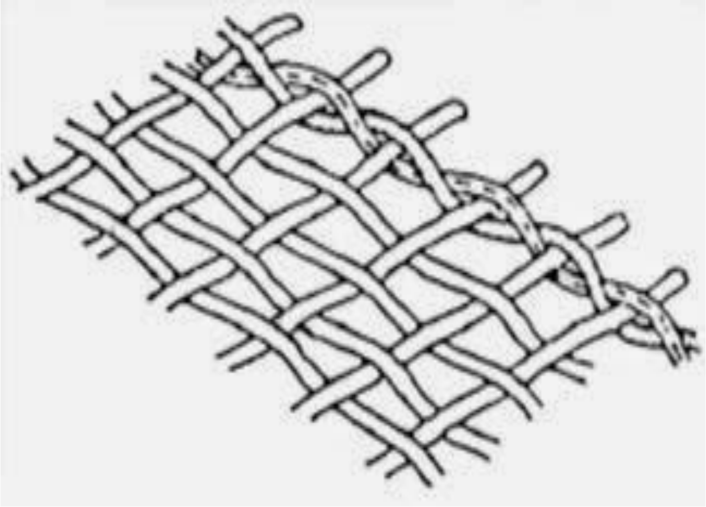
These type of selvedge are mostly produced in shuttle less narrow fabric weaving mechanism in which the picking takes place by means of needle.



Chain stitch

4**.** **Leno Selvedge :-**

These selvedge are obtained by binding the weft with strong additional threads working in gauze weave and by eliminating through cutting the protruding weft ends.



Leno selvedge

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Chapter – 10

Cold Weather Clothing

Clothing insulation is the thermal insulation provided by the clothing. In a purely physical sense, insulation is the process that reduces the transfer of heat energy between two objects of differing temperatures under normal conditions, a hot object that comes into contact with a cold object will lose heat to the cold object, as there's always a natural tendency for thermal equilibrium.

The mechanism of insulation works by conserving heat energy within an object and maintaining its temperature at a constant. Insulation does not create heat; instead, it traps pre-existing levels of heat to prevent its loss. Although the main purpose of clothing is to protect the wearer from cold, the fact that insulated clothing also shields from excessive warmth is often overlooked.

In normal circumstances, however, insulated clothing is mostly intended to keep us warm and fend off the biting cold. These are the main channels through which we lose heat in the cold:

1. **Conduction**

   With a normal base temperature of 37°C, our skin loses heat to almost everything it touches. That's why a chair becomes toasty after you've sat on it for a while! Our bodies lose heat 25 times quicker in water than in air – this is why it's crucial to remain dry in the outdoors and especially on mountains.

2. **Convection**

   Air flowing against the skin can also steal heat from the body. This is why many insulated jackets also incorporate a windproof outer layer to stop air from infiltrating the garment and making you cold.

3. **Evaporation**

   Sweating is the body's way of maintaining a stable temperature if you're undertaking intensive exercise (such as walking uphill). Sweating cools the skin if it gets overheated, but if you're trekking up a mountain and stop at the top, conditions will be colder and the cold sweat will stick to your skin, causing excessive cooling.

4. **Radiation**

   Heat generated by the body is also lost to the atmosphere through radiation. During intensive exercise, blood flow increases and occurs closer to the skin, process known as vasodilation. This causes the body to radiate and therefore lose more heat into the surrounding air.

Important Factors for Cold Clothing

Individuals differ greatly in their ability to tolerate and adjust to cold temperatures. Factors like age, sex, stage of life cycle, individuals belonging to different climate play a major role in adjusting to thermal conditions. The thermal balance is affected by heat production and heat loss.

1. **Metabolic Heat**

   The heat produced by the body due to the body parameters as well as the activity i.e. if a person is at rest the metabolic heat generated by the body is less compared to the metabolic heat generated by the body of the person during jogging.

2. **Wind Chill**

   Wind and the water are tremendously important factors in heat dissipation. The wind has the capacity of quickly moving away the warm air surrounded the body and work to evaporate sweat and carry off the resulting warm vapour. Wind is so important that temperatures are often quoted along with wind-chill factor. 80% of the heat losses are due to wind chill effect. Water conducts body heat much more rapidly than air. Since wind and water affects the rate of conduction, convection and evaporation, it is extremely important to clothing design.

3. **Air Permeability**

   It is one of the important fabric properties for maintaining thermal comfort in outdoor clothing it is important that air permeability is as low as possible because it should function as a wind protection. Air permeability of a fabric is a measure of how well it allows the passage of air through it.

4. **Moisture Vapor Transmission**

   The water vapour permeability of fabrics is an important property for those used in clothing systems intended to be worn during vigorous activity. The human body cools itself by sweat production and evaporation during periods of high activity. For instance, the clothing must be able to remove this moisture in order to maintain comfort and reduce the degradation of thermal insulation caused by moisture build-up in cold environment.

5. **Water Vapor Transmission**

   Water vapor transmission is essential in determining the breathability of clothing and textiles in outdoor wear as well as in indoor wear. A breathable textile allows extra heat loss by evaporation of moisture through the clothing layers. If clothing layers are impermeable the moisture is captured between skin and clothing and heat is accumulated in the body. As a consequence, heat and moisture build up, causing discomfort, wet skin and skin abrasion.

Material Used for Extreme Weather Clothing

1. **Down**

   Whether goose or duck down, it is still the best overall insulator. Down is lightweight, compressible and will last a lifetime. However, down can be expensive, and, when wet, it's worthless, since it provides no insulation and takes a long time to dry. It is not recommended for sweat-producing activities. The "fill power" number on the label refers to how much down the material contains - the higher the number, the more down the garment contains and the more insulation it provides.

2. **Fleece**

   Synthetic material with the same insulation properties as wool at half the weight. It is thin, soft, comfortable, easily laundered and will last years. It breathes well and dries quickly, so it can be worn for sweat-producing activities. Unfortunately, wind blows right through it making it unsuitable for the outer shell layer, but perfect for the insulating layer.

3. **Nylon**

   Another synthetic material, nylon is usually woven tightly and coated with urethane to make it waterproof. It is best suited for the outer shell layer.

4. **Polypropylene**

   This man-made material is thin, lightweight, conforming and soft. It provides the most "wicking," making it the perfect base layer material**.**

5. **Thinsulate**

   Fibers are about 15 micrometres (0.00059 in) in diameter, which is thinner than the polyester fibers normally used in insulation for clothing. Thinsulate is more effective due to the increased density of fibers with decreased size of fibers compared with more traditional insulation. The gaps between fibers not only reduce heat flow, but also allow moisture to escape. The insulation properties are beneficial for retaining some of the heat produced by the body for comfortable warmth while the moisture produced, most likely sweat, is supposed to evaporate. It retains its insulating properties when wet.

   The thermal resistance provided by Thinsulate products varies by the specific thickness and construction of the fabric. Values (US units) range from 1.6 for 80g fabric to 2.9 for 200 g fabric. Thinsulate is considered "the warmest thin apparel insulation" available. In fact, when equal thicknesses are compared, it provides about 1½ times the warmth of down and about twice the warmth of other high-loft insulation materials.

   It is used in a wide variety of clothing products, such as footwear, gloves, hats, and coats. It became popular in outerwear jackets as early as 1985. The fibers are thinner in diameter than polyester fibers, so the material is used as a waterproof synthetic alternative to down.

6. **Wool**

   Wool has many great properties. Oiled and tightly woven, it is waterproof, an excellent insulator even when wet, has great "wicking" abilities and lasts forever. However, wool is heavy, takes a long time to dry and can be very itchy.

7. **Polyester Batting**

   Polyester Batting and Polyester Fleece are two popular types of insulation for clothing and sleeping bags. Fleece is a stronger material but holds less air, so is convenient for stitching garments, whereas batting is more suitable as a filling for sleeping bags, combined with a stitched cover. We would expect that batting is a better insulator because it traps more air.

Clothing for Extreme Cold

Most of clothing designed for extreme weather conditions are designed with layers in order to adjust the material depending on temperature.

1. **Innermost Layer**

   Lightweight material like pile fabric, A base layer of soft material worn next to the skin to provide some insulation and made with synthetic materials that wick moisture away.

2. **Middle Layer**

   Lightweight insulating filling type material like polyester batting, wool or fleece such as Polartec, down or any new insulating material forms the middle layer depending on the activity. Polyester batting is generally used for clothing of light weight and better loft, which allows increased entrapment of air.

3. **Outermost Layer**

   The outer layer is a rugged, windproof material that is also breathable. It may or may not have insulation, depending on the circumstance and intended use. In most of the protective clothing, chemically-treated water and oil repellent fabric outers are popular. Alternatively, PU-coated nylon fabric or Goretex makes the outermost layer.

Methods of Measurement

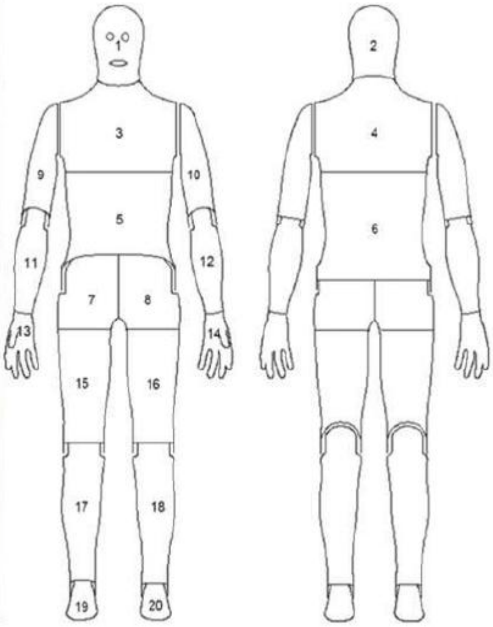
There are two methods of measurement of CLO value

1. **Sweating Guarded Hot Plate**

   Sweating guarded hotplate is the textile testing instrument for measuring of thermal and water-vapor resistance properties under steady-state conditions. By testing the thermal resistance and water-vapour resistance of textile materials, the tester provides a direct data for characterizing the textiles' physiological comfort which involve a complex combination of heat and mass transfer. The hotplate is intended to simulate the heat and mass transfer processes which occur next to human skin and measure the hence transport properties in a steady-state conditions involving combinations of temperature relative humidity, air speed, and in liquid or gaseous phase.

2. **Thermal Manikin System**

   "Newton" is a complete turn-key thermal manikin system used world-wide for a broad range of clothing and environmental testing. The manikin is constructed using a thermally conductive carbon-epoxy composite shell with embedded resistance wire heating and sensor wire elements. Standard zone configurations include 20, 26, or 35-zone models, Walking, breathing, physiological (human comfort) software, and female conversion accessories are also available



Units and Measurement

Clothing insulation may be expressed in clo units.

1 clo = 0.155 $\mathbf{K \cdot m^2 \cdot W^{-1}}$

This is the amount of insulation that allows a person at rest to maintain thermal equilibrium in an environment at 21**°C** (70**°F**) in a normally ventilated room (0.1 m/s air movement).

There are a number of ways to determine clothing insulation provided by clothes, but the most accurate according to **ASHRAE** Fundamentals are measurements on **heated manikins** and on active subjects.

Another unit that is used is " TOG ":

1 TOG = 0.1 $\mathbf{K \cdot m^2 \cdot W^{-1}}$ ≈ 0.645 CLO

1 CLO = 1.55 TOG

Down

Down is the light fluffy covering found beneath the feathers of ducks and goose. Most down grows on the breast and underbelly of the bird. Down is a three-dimensional cluster with dozens of soft fine filaments that spread out from its centre. Lighter than a feather. Down creates warmth through a process called ‘lofting’. Down clusters expand or loft to fill space and trap tiny pockets of air within their filaments to create thousands of insulating pockets. Down is used in goods such as jackets**,** pillows and sleeping bags etc

Type of down : There are two type of down i.e goose down and duck down

The biggest difference between goose down and duck down is volume of cluster / fill power

Down Colour

Down can vary in color, from white to dark gray depending on the age of the bird and the season in which the down was harvested. The color of down does not affect its ability to insulate in other words, a dark gray down will insulate just as well as a white down of the same size cluster and maturity.

Down Testing

1. Composition (Content Analysis)
2. Fill Power
3. Down Species
4. Net Fill Weight (Mass)
5. Fabric Down proofing
6. CLO value by sweating guarded hot plate
7. CLO value by thermal Manikin

Composition of Down

Down available in the international market is 90/10 80/20 60/40

90/10 mean 90% cluster and 10% feathers.

Down Feather

Feathers are the rigid plumage found on the outside of ducks and geese. They have a flat appearance and are two-dimensional in construction. As a two-dimensional structure, feathers are unable to trap air effectively and have little insulation value. The main purpose of feathers in bedding is to provide bulk and support.

1. **Broken Feathers**
    a. A feather is broken when more than 40 % of the shaft is missing.
    b. A bare shaft is also classified as a broken feather.
    c. A feather whose shaft has been “fractured” in the middle or close to the middle is also classified as a broken feather.
    d. Schleiss, or stripped feather pieces, are classified as broken feathers.
2. **Damaged Feathers**

    A feather is damaged when more than 25 % of the feather surface is missing but at least 60 % of the shaft remains.
3. **Quill Feathers**

    Quill feathers are stiff wing and tail feathers which are over 12 cm in length and/or which have a quill point exceeding 10 mm in length
4. **Water Foil and Land Foil Feather**

    Waterfowl are birds that are accustomed to and spend a substantial amount of time in water such as geese and ducks. Land fowl are birds that live only on land such as chickens, turkeys, and sparrows. Both waterfowl and land-fowl birds produce feathers, but only waterfowl produces down.

Down Species

If animals can breed together successfully, they are a species. When an animal is called by its scientific name, then that means it is being identified by its genus and species. Goose and duck bread together but quality of goose down is superior

Fill Weight

The relative warmth of a feather and down product is also influenced by its fill weight. Fill weight refers to the quantity of feather and down contained within the product and is usually displayed in grams. Assuming all other factors are equal when comparing a product, the product with the greatest weight of down fill will be warmer to sleep under.

Fill Power

Fill power is a measurement of the amount of space one (1) ounce of down (as shown in the cylinders below) will occupy in cubic inches when allowed to reach its maximum loft.

For example, one (1) ounce of 800 fill power goose down will loft to 800 cubic inches. So 850 fill power will 'bloom' or 'loft' higher than 800 fill power. The higher the fill power the larger the down cluster. Larger down clusters will loft higher; sleep softer, last longer and sleep warmer.

600 **700** **800**

600 **700** **800**

Down Measurements

Insulated clothing provides varying levels of insulation. Down (natural) and synthetic insulation are measured differently due to their different qualities. ‘Loft’ is the amount of space the down will take up in the garment directly related to how warm the material will keep you. The more space the down fills, the more air it can trap. Consequently, the higher the loft, the better the insulation and the greater the compressibility for a given weight of down.

The International Down and Feather Bureau (IDFB) regulates the industry and sets universal standards for measuring the insulating factor of down. The fill power is measured by putting a set mass of down into a cylinder, lowering a disc onto the down to compress it and finally, releasing it. The volume of the space the down expands to fill is the fill power. The IDFB’s tests use a Lorch cylinder with 30g of steam-conditioned down. A 700 fill power rating means that 30g of down expand to fill 700 cubic inches. Here’s a breakdown of the down insulation quality spectrum:

1. 500 fill power – standard quality
2. 600 fill power – good quality
3. 700 fill power – high quality
4. 800 fill power – extremely high quality
5. 900 fill power – very rare
6. 1000 fill power –extremely specialized jacket

Aside from fill power, the amount of down also influences the insulation capacity of the clothing item. Surely a 700 fill power jacket will be significantly warmer than a 500 fill power one with the same weight of down, but a jacket containing 300g of 500 fill power will still feel warmer than one having 30g of 700 fill power.

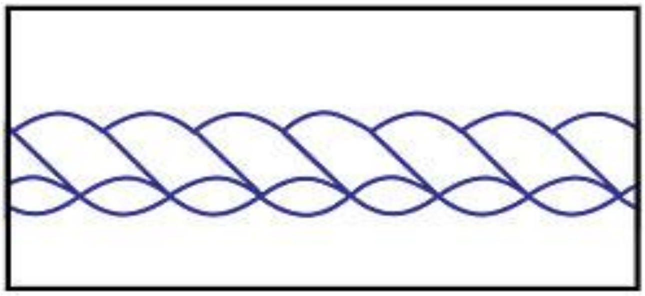
Fill Power Facts

1. The higher the fill power the larger the down clusters.
2. The larger the down cluster the higher the quality.
3. The higher the quality the longer it will retain its loft and firmness.
4. The larger the down cluster the more mature the bird The larger the down cluster the more air it traps.
5. The larger the down cluster the higher it will loft.
6. The larger the down cluster the better the insulating power.
7. The larger the down cluster the lighter the down pillow, down comforter or feather bed will be.

Down Garment Construction Techniques

1. **Sewn-Through**

   Sewn-through or stitch-through is the simplest construction technique. The shell and liner are pinched and stitched directly together to join the two layers. There's no vertical baffle wall, though the individual channels of down. Sewn-through construction creates colder spots at the seams, allowing heat to escape, so it's not better for warm weather bags.

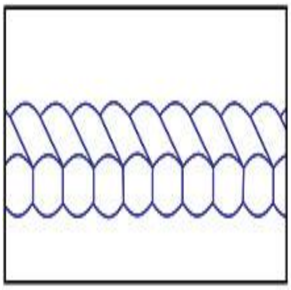


2. Baffles

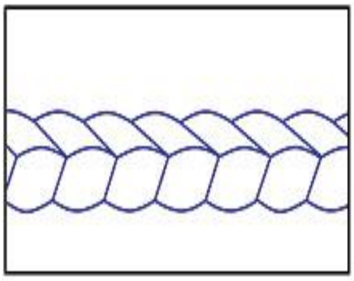
Down bags are usually built with baffles, vertical walls of light weight fabric or mesh that separate small quantities of down and keep it from shifting around. Though technically baffles are the dividing walls between the insulation, the individual channels or chambers are commonly referred to as the baffles too. Different techniques may be used in different areas of the same sleeping bag.

3. Box Baffles

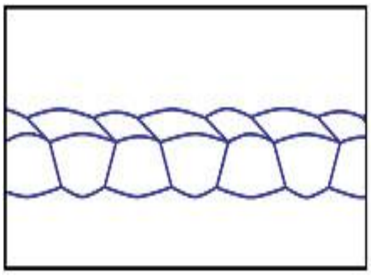
Box baffles is box shape or slant or trapezoidal boxes, for better thermal efficiency. Box style baffles have an internal baffle wall and are warmer and heavier than sewn-through baffles. For even greater warmth, box baffles can be double layered on top of one another with their walls offset, like bricks, for less heat loss.



Box



Slant box



Trapezoidal box

Chapter – 11

Stitching

In the textile arts, a stitch is a single turn or loop of thread, or yarn. Stitches are the fundamental elements of sewing, knitting, embroidery and needle lace-making, whether by hand or machine.

Classification of Stitch.

There are many classes of stitch. Among then chain stitch and lock stitch are commonly used in garments production. Stitch class is usually expressed numerically are as

1. Class-100 (Chain Stitch),
2. Class-200 (Hand Stitch),
3. Class-300 (Lock Stitch),
4. Class-400 (Multi Thread Stitch),
5. Class-500 (Over Edge Stitch),
6. Class-600 (Covering Chain Stitch).

The basic principle of all machine sewing depends on consistent loop formation. During sewing the needle descends through the fabric to the bottom of its stroke and as the needle rises a loop of sewing thread is formed in the scarf of the needle.

The sewing machine hook be it rotary or oscillating shuttle interlocks the needle thread with the bobbin thread. A loop, used in chain stitch formations, interloops the thread that it carries with another thread.

Steps of Stitch Formation

There are five basic steps to the formation of all stitch types.

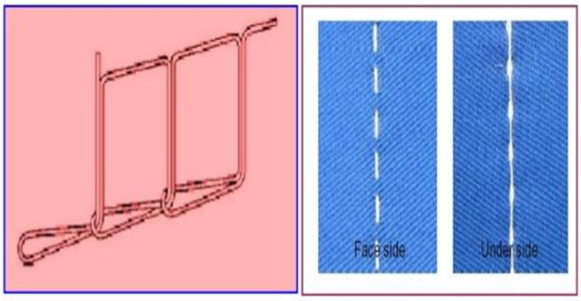
1. **Penetration** – the needle penetrates the fabric carrying the needle thread
2. **Loop formation** – a loop of sewing thread is formed in the scarf of the needle as the needle begins to rise from the bottom of its stroke
3. **Conformation** – this is where the threads are arranged above, below or around the material being sewn
4. **Cast off** – is where the needle thread loop is freed from the lower stitch forming device

5. **Stitch setting** – when the thread is drawn onto or into the material

Stitch Types

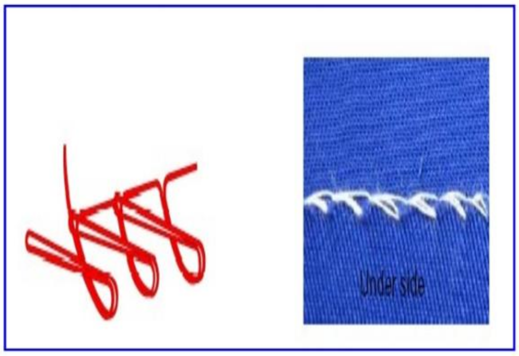
1. **Single Thread Chain Stitch**

   Single thread chain stitch is formed using just one sewing thread introduced by the sewing needle. Stitch Type 101 is most often used for temporary stitching. Its main disadvantage is its tendency to run back from the finishing end of the seam.



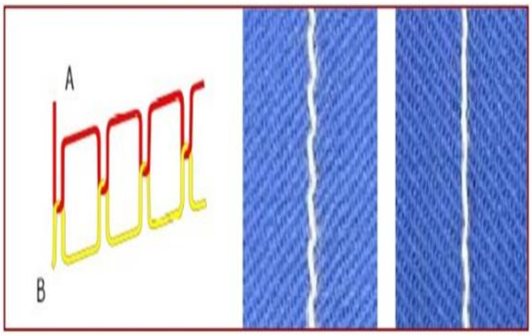
2. **Single Thread Blind Hemming**

   A derivative of stitch type 101 is stitch type 103 known as single thread blind stitch or blind hemming. Again its main disadvantage is seam runback. This stitch is formed by using a curved needle which enters and exits the fabric from the same side carrying a needle thread. The needle thread interloops with a blind looper on the surface of the material. Typical applications are hemming and lapel padding operations.



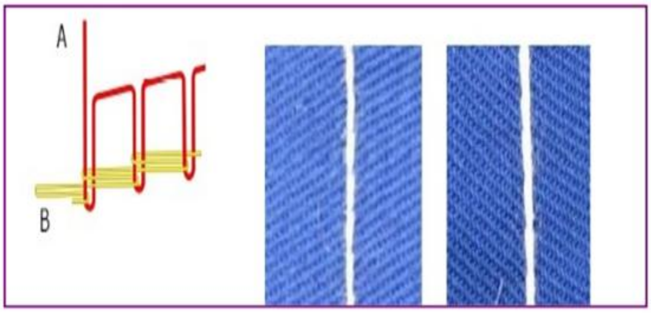
3. **Lock Stitch**

   The most common stitch type is without doubt the 301 single needle lockstitch. Its main advantage is that it looks the same on the top as it does on the bottom. It produces tight, strong, low bulk seams but its main disadvantages are low elongation and low productivity due to the need to frequently change the under thread bobbin.



4. Chain Stitch

Higher productivity and greater seam elongation can be achieved by using a 401 single needle chain stitch. The disadvantages of using this stitch type are that it isn't reversible and being a chain stitch it is prone to seam runback and the seams it produces tend to be bulkier than those created by a lockstitch. It is true to say that the 401 chain stitch has higher elongation than the 301 lockstitch and delivers lower seam pucker when the cause of the pucker is structural jamming.



5. Double Needle Lock Stitch

6. Double Needle Chain Stitch

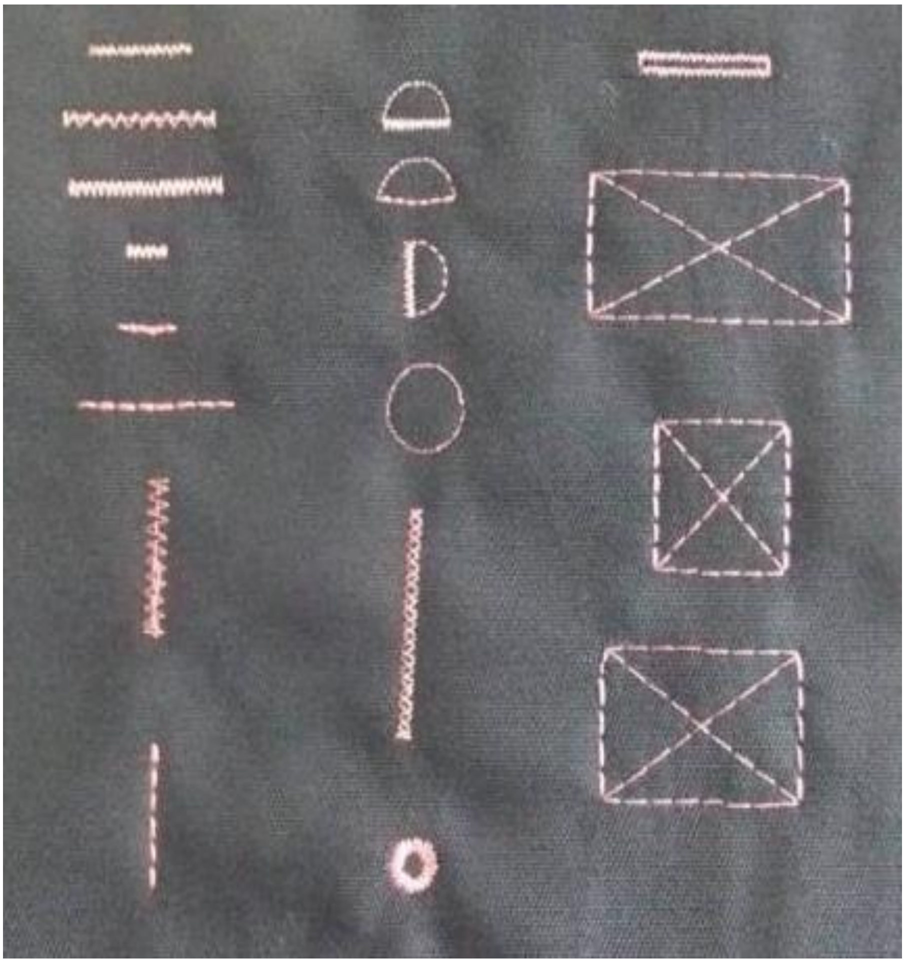
7. Zig Zag Stitch

Where there is a requirement for higher seam elongation with either lockstitch or chainstitch, a zig zag formation may by used. For example, in corsetry. To produce either zig zag formation the needle bar moves laterally as the material is fed. The main drawback is that the zig zag stitch formation may not deliver the desired appearance.

Bar Tack

In sewing, bar tack, refers to a series of stitches used to reinforce areas of a garment that may be subject to stress or additional wear. Typical areas for bar tack stitches include pocket openings, buttonholes, belt loops, the bottom of a fly opening, tucks, pleats and the corners of collars. Bar tacks may be sewn by hand, using whip stitches, or by machine, using zigzag stitches.

The process for sewing a bar tack is essentially to sew several long, narrowly-spaced stitches along the line of the bar that will be formed, followed by short stitches made perpendicular to the long stitches, through the fabric and over the bar. In some garments, such as jeans, the bar tack will be sewn in a contrasting color.



Chapter – 12

Waterproof, Breathable Lining Fabric

When it comes to outdoor wear, from shoes to jackets or mid layers, the best and most useable fabrics are breathable, waterproof, mean it allows body moisture and vapours to be released, so you can use it for active wear without overheating or feeling discomfort.

Waterproofing

Waterproofing is nothing but preventing the passage of both air and water through a fabric. So they should have some property to prevent both air and water passing through them. This finish makes the wearer feel uneasy and uncomfortable as the air circulation is not there.

A film on the surface of the fabric should be formed for the prevention of air and water. When a uniform coating of suitable substances is produced on the surface of a fabric, the interstices between the warp and weft yarns are blocked by the continuous film or substance and both water and air not pass through the treated fabrics. The fabric should not become unnecessarily stiff and the fabric should have soil repellent property. The finish should not alter the fastness properties or dyed material, feel, strength etc., of the fabric.

The more resistant to higher water pressure, the higher the waterproof rating. There are two common types of ratings: Range: from 3,000 to 28,000mm (height of water column - pressure) PSI (Pounds per square inch resistance) .If rated at 7,000mm waterproofing, it means this material will stand up to a column of water 7,000mm high, without letting any moisture in in a 24 hour period. MM ratings range from 3,000 or so at the low end up to 28,000 on the high end

Breathability

Waterproof and breathable fabrics are resistant to external moisture coming in but also allow perspiration vapor to pass through to the outside. The breathability of a fabric (measured in $g/m^2/24$ hours) tells you how many grams of moisture vapor can pass through a square meter of the material in 24 hours. The higher the rating, the better for athletic activities.

Non-breathable waterproof apparel fabrics are best used for lower-intensity activities in the most extreme weather conditions. They offer very high weather protection, but don't allow any internal moisture vapor to escape

Breathability rating that will let out perspiration and Waterproof Ratings how a fabric rates on a waterproof scale ability to withstand water under pressure.

Sealed Taped or Welded Seams

Even if you have the best materials and/or coatings or laminates, remember that needles are often used to attach pieces of fabric together to make up garments and each needle puncture creates a small hole that may allow water to sneak inside.

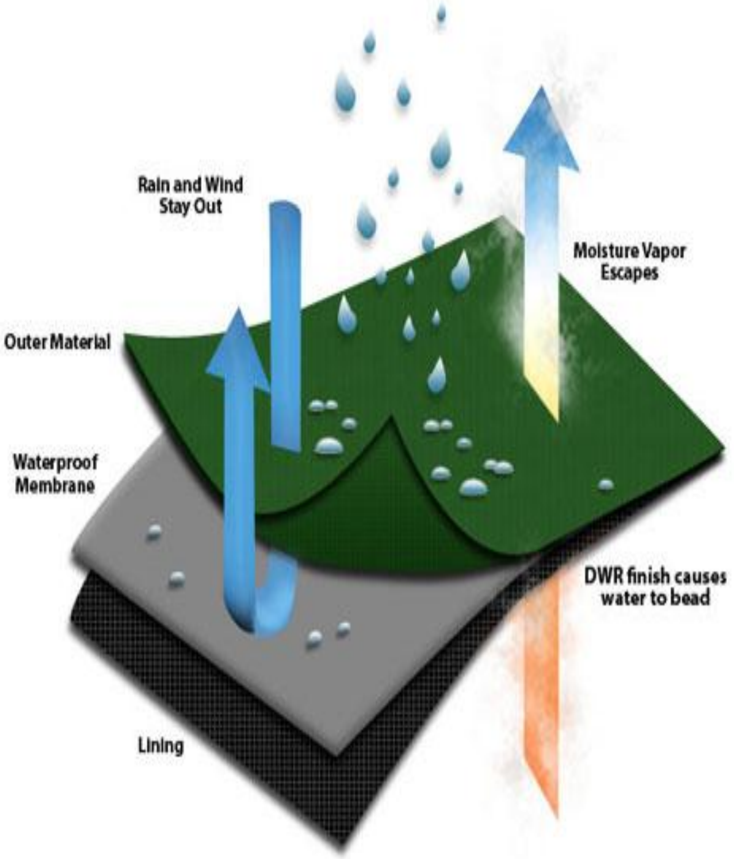
Highly rated water resistant clothing has either waterproof sealed or taped seams. Another garment assembly method used by some manufacturers is welded seam technology, which binds multiple fabric pieces together. Fabric welding is a bonding process that includes the use of heat and pressure to 'fuse' pieces together so no puncture marks are made in the material. Manufacturers' will typically indicate what type of seam protection is built into each of their garments, and it is frequently visible, as well.

Standard Seaming

Waterproofed/Sealed Seam

Breathable and Waterproof Membranes

Most breathable and waterproof apparel fabrics consist of a membrane that contains millions of microscopic holes (pores) per square inch. These tiny holes might be up to 20,000 times smaller than a drop of water but still allow molecules of water vapor to pass through. These pore size holes allow the membrane to be completely waterproof while allowing evaporating perspiration to escape.



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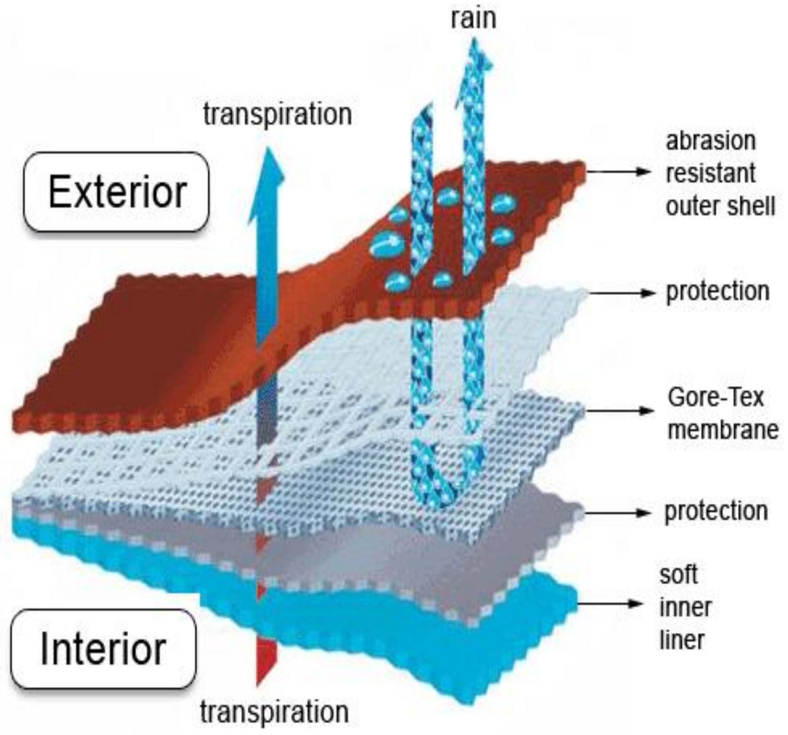


Waterproof Breathability Rating Chart

3,000 to 7,000mm: *Water resistant* - this is minimal protection for activities in light rain and snow

7,000 to 9,000mm: *Good water resistance* - typically has sealed seams for mild rain and snow conditions

10,000 to 19,000mm: *Very good protection* - for mild rain, snow, and melting conditions up to intermittent heavy rain and wet snow

20,000mm or higher: *Excellent protection* - for heavy rain, heavy snow, nearly all wet environments

Testing

1. **Breathability**

   Breathability tests show how many grams of water vapour are able to pass through a fabric in a set time period as a RET (Resistance of Evaporation of a Textile) or MVT (Moisture Vapour Transmission)

2. **MVT - Moisture Vapour Transmission**

   Moisture vapour transmission relies on the existence of a temperature/pressure gradient between the inside and outside of the breathable garment.

   Once body moisture reaches the inner face of the garment, it must pass through the fabric and then evaporate on the surface. breathable products work best when the air inside is humid and warm, the air outside cold and dry to evaporate the excess moisture.

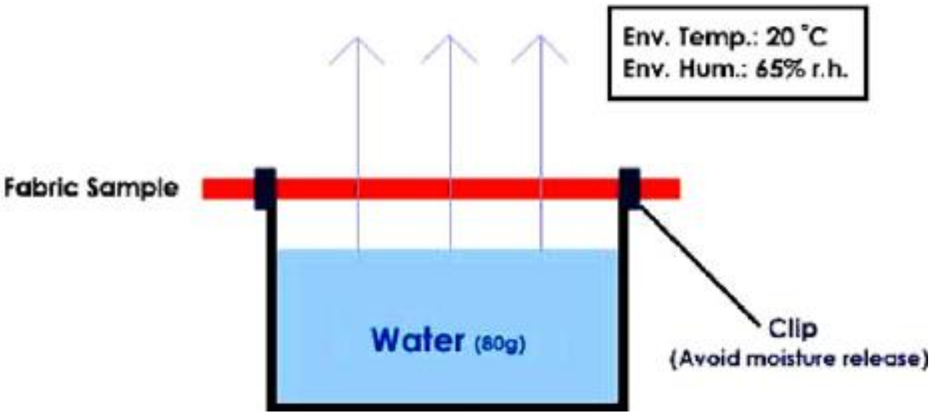
3. **RET - Resistance of Evaporation of a Textile**

   Simply put, this shows the levels of resistance the fabric has to allow evaporation. The lower the resistance, or RET, the better the breathability (the more RETS) or energy it uses, the less able to breathe the garment is basically: A RET of 0 has excellent breathability whilst a RET of 30+ is not very breathable at all.

Method of Testing

1. **The Upright Cup Test**

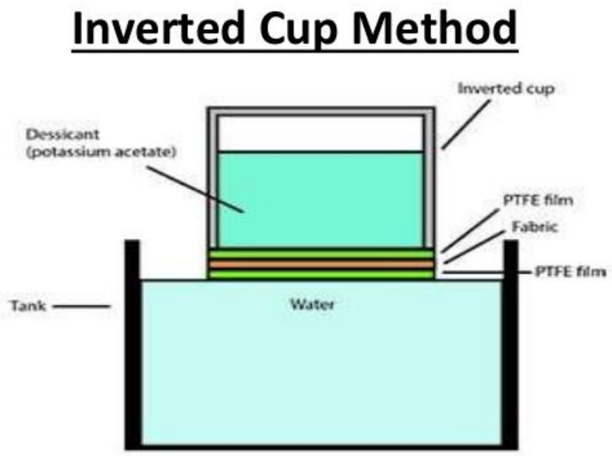
   This measures water vapour transmission through the garment. The fabric is secured onto an upright, sealed cup which is tested over a 24 hour period to see how much moisture is passed through the fabric, into the cup. The cup is then weighed, and the result of this weight indicates the grams per square metre- written as (gr/24hrs/m²) that the fabric can release as moisture. The higher the amount e.g. 10,000 g, the higher the levels of breathability.



2. **The Inverted Cup Test**

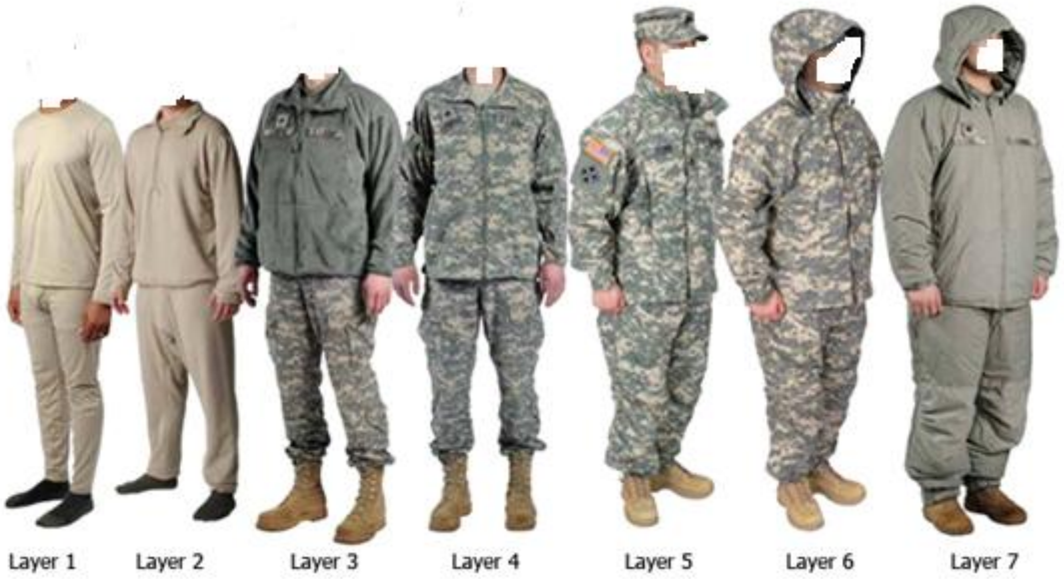
   This measures amount of water absorbed by the garment. The fabric is placed onto a waterproof, moisture vapor permeable membrane and then held in a controlled amount of water.

   Then an inverted weighted test cup is sealed and placed on the sample. After a 24hour time frame, the cup is weighed; showing the amount of water picked up and held by the fabric.



Chapter 13

Extended Cold Weather Clothing System (ECWCS)



The Extended Cold Weather Clothing System (ECWCS) is a protective clothing system developed in the 1980s by the US Army

1. **Ist Generation**

   The entire ECWCS ensemble consists of 22 items to be used in an insulated, triple-layering fashion, with the polypropylene undergarments as Layer 1, the polyester shirt/bib, liners and cotton/nylon trousers as Layer 2, and Gore-Tex outer garments as Layer 3.

   The parka and trousers are themselves constructed in a three-layer fashion consisting of an outer layer of abrasion-resistant taslan nylon, an intermediate layer of durably waterproof, windproof, and Gore-Tex membrane (protected with a layer of nylon tricot and originally in a four-color camouflage print), and a hung inner layer of un-laminated nylon. The whole is seam-sealed.

2. **2nd Generation**

   The second generation included two different layers made with Polartec fabrics: the Polartec shirt and overalls. When used in combination with other layers in the ECWCS system, the system provides protection between +40 °F and −40 °F (+4 °C and °C). The parka was improved by vents to help deal with the condensation problems resulting from the use of "waterproof-breathable" fabric.

3. **3rd Generation**

   Initial fielding of the system began in August 2007 in Afghanistan. The water-resistant "soft shell" is far more breathable than any "waterproof-breathable" garment and is used for most field applications, back-stopped by a waterproof nylon parka.

   The multi-layered insulating system GEN III allows the soldier to adapt to varying mission requirements and environmental conditions. Materials offer a greater range of breathability and environmental protection, providing greater versatility in meeting soldiers' needs.

An innovative design that reduces bulk, taking up 33 percent less space, and weighing 25 percent less than its predecessor systems. The Gen III ECWCS design allows moisture to escape and at the same time has water-resistant properties.

12-piece kit that enables soldiers to utilize seven different layers, depending on the mission and environment. The system functions through insulation, which resists the transmission of heat, traps air, and wicks moisture away from the body; layering, which increases air space and allows easy adjustment to a soldier's activity level; and ventilation, which allows moisture to escape. soldiers can protect themselves from ranging from 40 to minus 60 ^{0}F

a. **Level I**

Base Layer: Worn next to skin by itself or in conjunction with other levels for added insulation and to aid in the transfer of moisture.

Light-weight undershirt and drawers are designed to wick moisture and to provide protection from the elements.

Constructed with Polartec Power Dry Silkweight material, this layer is highly breathable, wicks moisture away from the skin and dries fast, providing evaporative cooling in warmer weather and insulating in cool weather, all with less weight and bulk than previous systems.

b. **Level II**

Base Layer: worn next to skin by itself or in conjunction with other levels for added insulation and to aid in the transfer of moisture.

The GEN III Mid-weight shirt and drawers provide light insulation in mild climates and serve as a base layer in cold climates.

Constructed with Polartec Power Dry grid material, this layer provides extra warmth in cooler conditions but still wicks moisture away and dries fast. The material offers stretch for increased comfort and is lighter weight with less bulk than previous systems.

c. **Level III**

Primary Insulation Layer: Worn underneath shell layers or worn as an outer garment in cool conditions.

The GEN III High-Loft Fleece Jacket is the primary insulation layer for use in moderate to cold conditions.

Constructed with Polartec Thermal Pro® material the insulation on the Level III Jacket creates air pockets that trap air and retain body heat providing outstanding warmth without weight. With excellent breathability, the Level III jacket dries quickly with increased warmth while maintaining lower bulk and increased durability than previous systems.

d. **Level IV**

Shell Layer: Designed to be worn with base and insulative levels in transitional environments to provide wind and sand protection.

The GEN III Wind Jacket is designed to act as a low volume shell layer that optimizes the moisture wicking properties of other GEN III insulative and next-to-skin layers. It is also designed to be worn under body armor.

Constructed from stretchable nylon with a water resistant finish, this full-zippered jacket provides wind and sand protection with low weight and bulk.

e. **Level V**

Shell Layer: Designed to be worn with base and insulation levels for use in moderate to cold conditions.

The GEN III Soft Shell Cold Weather Jacket and Trousers are designed for use in moderate to cold weather conditions as a soft shell combined with other base and insulative layers.

Constructed with stretchable and breathable water resistant materials, the Jacket and Trousers provide light-weight, low bulk and extreme comfort for movement.

f. **Level VI**

Shell Layer: A waterproof barrier designed to be worn over other levels in moderate to cold wet conditions alternating between freezing and melting.

The GEN III Extreme Wet/Cold Weather Jacket and Trousers are designed for use in moderate to cold wet conditions as a hard shell layer combined with other base and insulative layers.

Constructed with two-layer GORE-TEX and seam-sealed throughout, the Jacket and Trousers provide an outstanding light-weight, completely waterproof, windproof and breathable level of protection against the elements with 50% less bulk than previous systems. Level VI also incorporates near infrared signature reduction technology further enhancing soldier survivability.

g. **Level VII:**

Soft Shell Insulative Layer: The outermost level of protection in the system designed for use during static operations in extreme cold and dry conditions.

The GEN III Extreme Cold Weather Parka and Trousers are designed for use during static operations in extreme cold, dry conditions.

Constructed with an outer shell fabric that has a water resistant finish and with Prima Loft Sport thermal bonded high-loft insulation, Level VII is highly durable and breathable. The Parka and Trousers maintain warmth even when wet and provide protection in extreme cold conditions during static operations.

Chapter – 14

Clothing

Anything, which is used for covering the body is clothing item, the objective of clothing items are as under:

1. Protection
2. Fashion
3. Appearance / Look

Types of Clothing

There are two types of clothing item that are woven and knitted.

1. **Weaving**:

   Weaving is textile craft in which an interlacement of two sets of yarns or threads (warp or end and weft or the filling) at right angle to make a fabric, with the help of machine called loom. which has necessary arrangement for this purpose

2. **Knitting**

   The process in which fabrics are produced by interlocking one or more or by forming loops. It involves the use of one or more yarn by forming loops. It involves the use of one or more yarn moving in one direction. These are knitting over itself with a series of interloping."

Clothing Items in SVC

1. Shirt and Trousers
2. Coats
3. Cover all
4. Jersey
5. Socks
6. Berets
7. Sleeping Bags
8. Fd Jacket etc

Garments

Garment is main part of clothing item. There are three types of garments (Woven and Knitted)

1. **Under Garments**. Generally cotton and Woollen clothes are used in these garments which are vest and drawers the purpose of using under garments are to protect from the perspiration and protection from cold.
2. **Covering Garments**. Generally blended fabrics cloths are used in these garments which are shirt and trousers.
3. **Over Garments**. Woolen, worsted, synthetic and cotton material are used in these garments.

Size Roll.

Size roll is very important in the clothing items, size roll is chart of measurement of human body and as well as measurement of different parts of garments. Cutting is based on size roll. The primary purpose of introducing this system is to provide standard classification, size designations and body measurements for the guidance pattern and ready to wear garments to cover all the sizes and varied figures, it is necessary to prepare a standard size chart for all types of figures in the human body without resorting to talking actual measurements of the body. Thus two-way system has been created which includes the sizes, based on chest and height relation and body type slim, normal seat etc based on chest and waist.

Human Body

Measurement of human body consists on 4 categories.

1. Small
2. Medium
3. Large
4. Extra Large

Measurement of human body consists on 8 equal parts

1. Top of head to chin
2. Chin to chest (Over Nipples / Scye line)
3. Chest to nave point
4. Nave point to hip line (Over pubic arc)
5. Pubic arc to thigh center
6. Thigh to below knee
7. Below knee to shin
8. Shin to the bottom of foot

Main Parts of Shirt and Trousers

1. **Shirt**.
   a. Front part
   b. Back part
   c. Yoke
   d. Sleeve
   e. With or without cuff
   f. Collar & pocket
2. **Trousers**.
   a. Front part
   b. Back part
   c. Belt
   d. Pockets and fly loops

Main Measurements of Shirt and Trousers

1. **Shirt**.
   a. Shirt length
   b. Round chest

c. Yoke width / length

d. Sleeve length

e. Collar length

f. Pocket size

2 **Trousers**.

a. Side length

b. Leg length

c. Round waist

d. Round seat / hip

e. Body rise

f. Round bottom

Method for Measurement of Garment.

1. Garments should be laid out flat with out tension on a smooth and flat surface with crease and folds removed.
2. For Measurement of seat waist chest and seat of washed garments a small tension is applied to the garment in order to remove all the creases and fold so that the garment is laid flat on the table, garment is not to be stretched.
3. All garment openings should be Measurement from the outside edge to outside edge unless other wise specified.
4. Measuring tape must be straight and touch across the garment during for all straight and touch across the garment during measuring

5, **Measurements be made as under**:-

a. **Height**. Measurement is taken from the top of the head to the sole of foot when the person is standing.

b. **Chest**. Measurement is taken on the nave line.

c. **Sleeve Length**. Measurement is obtained by placing the tape Measurement on the crown of the sleeve and then to wrist bone.

d. **Trousers Length**. Measurement is taken from the hip hone on the waistline down to the floor minus 4 – 6 cm according to the taste and fashion. Inside Measurement gives the finished length of the inside leg from the fork to the bottom of the permanent turn-up.

e. **Shirt Length**. From neck bone to downward up to the tip of 1st finger.

f. **Leg Length**. From crutch point to bottom of foot.

g. **Scye Line**. Chest line (Measurement over both nipples)

h. **Waist line**. Over nave point all around.

i. **Hip Line / Seat**. Measuring all around over seat covering the maximum portion of public etc.

j. **Hem**. Fabric folded and stitched at the end of garment.

k. **Yoke**. Distance between the two shoulders.

l. **Body Rise**. In the difference between the outside and inside leg Measurement. Collar size all around the neck.

m. **Bottom**. According to the requirement.

Stitching of Clothing Items.

Stitching play very important role in the clothing items. Type of stitch is also very important. Different types of stitches are lock, chain, quilting, cross, over lock, zig zag, padding, back and falling / blind stitches.

Formulae for Taking Measurement of Shirt and Trousers:-

S. No	**Parts**		**Formula**				
1.	Shirt length	=	$\frac{\text{Height}}{8}$	X	3.5	±	1 inch
2.	Trousers length	=	$\frac{\text{Height}}{8}$	X	5	-	1 inch
3.	Sleeve length	=	$\frac{\text{Height}}{8}$	X	2	+	5–6 inch
4.	Body Rise	=	$\frac{\text{Height}}{8}$		Waist 10	-	1 inch
5.	Leg Length	=	Trousers Length		-	-	Body Rise
6.	Youk	=	$\frac{\text{Height}}{8}$	X	2	+	5–6 inch

Defects of Clothing Items.

1. **Major and Minor Defects**. If the defects are in a small area affecting appearance only without affecting serviceability / durability these are known as minor defects other wise the same will be treated as major defect. In short in weaving if one warp or weft thread is disturbed affecting appearance only it will be considered as minor defect, if the same is more than one affecting serviceability / durability and also appearance then it will be treated as major defect. Two minor flaws are treated as one major defect.

2. **Defect of Fabric Used in Garment**.

   a. **Weaving Defect**.

   Missing or broken ends, missing or broken picks, loose end, slack end, course ends or ricks, wrong draws, subs (warp and weft), snarls, temple-marks, pick out or picked up places, thick and thin placed, knots, weft bars smash, cracks, damaged / irregular selvedge, weak places.

   b. **Knitting Defects**.

   Loose / tight knit, Knots, Darning nips.

c. **Dyeing Defects**.

Streaky or cloudy dye, listing defect, Shade variation from centre to end or end to end, Patchy dye, Off shade.

d. **Stitching Defects**.

Missing, broken, zig zag, Puckering, Stitching and needles hole.

3. **General Defects in Garments**.

    a. **Cutting defects**.

    (1) Cutting not as per measurements

    (2) Cutting not as per pattern

    b. **Stitching defects**.

    (1) Improper balance garment

    (2) Disalliment of garment / components

    (3) Puckring at seam

    (4) Jump stitch

    (5) Less / more no of stitch / inch

    (6) Disalliment / improper distance between buttons and buttons hole.

4. **Finishing defects**.

a. Cropping not properly done

b. Pressing defects

c. Improper folding

d. Improper packing

Chapter - 15

Testing Standards

Standardized testing is the greatest single social contribution of modern psychology and it may be the most useful evaluation method available for human resource-intensive endeavors. One of the main purposes of testing standards is to check product quality and use ability. Use ability depends on the context of use, design, environment constraints, importance of usability, etc.

The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

Quality assurance measures such as regular product testing. Product testing is a key in gauging product quality, ensuring regulatory compliance and assessing the performance of product materials. It is a vital basic tool during the processing of a product raw material into the product. It also helps the distributors and consumer to determine the end product's quality.

So how can you make sure you are buying quality?. Whether a product ticks your requirement or not depends on all of its different components and how they work together. What distinguishes high-quality from low-quality product is testing of product

The primary purpose of product testing and analysis is to assess product performance. Product performance must be considered in conjunction with end use; therefore, tests are performed with the ultimate end use in mind.

Manufacturers / Organization / Government establish specifications for various end uses and use these specifications to assess the suitability of product/s for the intended use and it also use specifications in acceptance testing of their suppliers' products.

The main objective of testing and analysis are research & development, quality control, comparative testing, analyzing, product future, government regulation, selection of raw materials, product control, process control, process development, product testing etc.

Test methodologies developed for a specific research application within one laboratory often gain wider acceptance and eventually are developed into industry-wide standard test methods.

1. **Quality Control**

   Quality-control testing aids the manufacturer in assuring that the expected level of quality is maintained.

2. **Comparative Testing**

   Comparative testing compares two or more products being considered by a company or government agency.

3. **Analyzing Product Failure**

   Testing is done in this case to pinpoint defects in processing or design.

4. **Government Regulations**

   Textile product testing is sometimes performed in order to meet government regulations. Such regulations may require mandatory testing of products before they can be legally sold.

5. **Product Testing**

   The performance of a finished article in actual service could be the object of a product test.

6. **Standard test methods and specifications:**

   The term standard is used often in regard to testing of products. It can refer to the actual test method, or to the minimum acceptable level of performance on a particular test. It is generally used as an adjective, in which we mean uniform, controlled or widely accepted as in a standard test method or a standard performance specification.

Development of Standard Test Methods

Test methods are developed for products by several different organizations. They are typically developed in response to a need expressed by an individual manufacturer, a product user, or occasionally by a consumer group. Validity of the test method and the practically test method in everyday use. Validity means whether the proposed method actually addresses the problem. In most organizations that develop standard test methods, once the test procedure is clearly defined, the proposed method then undergoes inter-laboratory trials.

Standard test method organization

1. **ASTM Standard (American Society for Testing and Materials)**

   ASTM International organization formerly known as American Society for testing and materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. The standards created by ASTM are designed to enhance safety and improve the quality of consumer and industrial products.

2. **AATCC Standard (American Association of Textile Chemists and Colorists**)

   Professional association that provides test method development, quality control materials, educational development, and networking for textile and apparel professionals throughout the world

   AATCC has developed more than 200 textile-related standards, including test methods, evaluation procedures, and monographs. All standards are developed and updated by volunteer members, through research committees. All industry stakeholders may participate in the standards-development process.

   The content of many AATCC methods form the basis of equivalent ISO methods. AATCC also offers test method proficiency programs and quality control products for use in conducting its test methods.

3. **ISO Standard (International Organization for Standardization)**

   An independent, non-governmental international organization with a membership of 163 national standards bodies. It is the world’s largest developer of voluntary international standards for products, services and good practices. Certification of compliance with ISO standards can be a useful tool to add credibility, by demonstrating that a product or service meets the expectations of your customers. For some industries, certification is a legal or contractual requirement.

   ISO Standards ensure that products and services are safe, reliable and of good quality. For business, they are strategic tools that reduce costs by minimizing waste and errors and increasing productivity.

4. **EN Standard**

   European Standards (abbreviated ENs owing to the more literal translation from French/German as European Norms) are technical standards drafted and maintained by CEN (European Committee for Standardization), CENELEC (European Committee for Electro technical Standardization) and ETSI (European Telecommunications .) EN std are safety standards.

5. **BS EN Standard**

   In many cases standards are double prefixed "BS EN" which means this is the UK version in English of a European harmonized standard (in some cases the prefix may be "BS EN ISO" where an international standard has been adopted by Europe as a European standard.

6. **BS Standard(British Standards)**

   British Standards (BS) are the standards produced by the BSI Group which is incorporated under a Royal Charter (and which is formally designated as the National Standards Body (NSB) for the UK).The BSI Group produces British Standards under the authority of the Charter, which lays down as one of the BSI's objectives

7. **PS Standard (Pakistan Standards)**

   The Pakistan Standards and Quality Control Authority (PSQCA) is an autonomous body subordinate to the Ministry of Science and Technology (Pakistan) of the Government of Pakistan. Its main objective is to regulate and enforce quality standards in Pakistan. Anything that is certified by the PSQCA is issued the Pakistan Standards label.

8. **IDFL Standards (International Down and Feather Testing Lab)**

   The largest down and feather testing **l**aboratory in the world .IDFL provides testing services for filled-textiles like: down and feather material and products. IDFL also offers audit and inspection services.

   IDFL's laboratories are certified by various quality regulation institutions such as IDFB, IDFL also conducts tests and research according to quality standards established by AATCC**,** ASTM and IDFB etc

Format of Standard Test Methods

Test methods usually have a standard form, regardless of which organization developed them. The sections of a test method include the following.

1. Test number and name

   This usually also includes the year that the method was accepted or revised by the organization.

2. Scope and purpose

   This state's what types of materials are covered by the test method and for what purpose the method was originally intended.

3. Definition of terms

   Any terms that are not generally understood or that have definitions that are specific to the test method is defined.

4. Safety precautions

These are now required for most methods. They prescribe special handling precautions for chemicals or equipment to be used during performance of the test.

5. Apparatus and materials

   This section describes the instruments, devices, and materials that are required to conduct the test.

6. Test specimens

   The size, number, and preparation of test specimens are explained.

7. Procedure

   This section outlines in detail the steps to follow in performing the test, and any related factors that need to be controlled as the test is performed.

8. Evaluation or calculation of results

   This explains how to acquire the data or result. It includes explanation of any factors, such as ratings or formulas, needed to determine the results.

9. Report

   This section indicates what information should be given in the report describing the test results.

10. Precision and bias

    The precision to be expected from the test is outlined and may know biases in the test are identified.

11. Note: Footnotes of additional information, including suppliers of instruments and material, as well as literature reference, are included in this section

Test Criteria:

During your course in testing and analysis, you will learn the principles of numerous tests that are used to evaluate the performance of materials, and you will likely have the opportunity to conduct many of these tests yourself. You will find that some standard test methods are easier that others to understand and interpret, and that some seem to be very applicable to end-use situations, while others do not. In evaluating a material, you may be faced with a choice between two or more test methods that could be used to test a particular performance characteristic. Test methods should meet three criteria, which can also be used when selecting among several standard methods. These criteria are simplicity, reproducibility, and validity.

Simplicity

The criterion of simplicity means that a test method should be easy to read and understand. It should provide enough information so as to leave no doubt as to how to perform the test, the procedure should be easily mastered with a minimum of practice, and the results should be easily obtained and interpreted.

Repeatability

Repeatability test–retest reliability is the closeness of the agreement between the results of successive measurements of the same measure carried out under the same conditions of measurement. In other words, the measurements are taken by a single person or instrument on the same item, under the same conditions, and in a short period of time

Reproducibility

The results of a test should be reproducible with respect to user, time, and location. Two individuals who perform the same test on the same specimen should obtain the same results. Using the same test specimen, you should be able to obtain similar results from one day to the next

Tests should also be reproducible with respect to location. Using identical specimens, a student working in a laboratory in Athens, Georgia, should obtain the same results as a student performing the same test in Karachi Pakistan, provided that the two students are correctly following the test procedure.

Validity

The procedure followed in a textile test method should duplicate or closely simulate the actual end-use situation. In other words, the test method should be applicable to the end use.

Chapter – 16

Important Test Carried Out on Fabric

1. **Physical Tests**
    - a. GSM
    - b. Thread
    - c. Count of yarn
    - d. Shrinkage %
    - e. Breaking Strength
    - f. Tear Strength
    - g. Weave
    - h. Wales & Courses
    - i. Pressure Head Test
    - j. Bowl Test
    - k. Cone Test

    For waterproof fabrics (i–k)

2. **Chemical Tests**
    - a. Nature of dye
    - b. Washing
    - c. Perspiration
    - d. Rubbing
    - e. Dry Cleaning
    - f. Copper %
3. **Fiber Tests**
    - a. Quality of Wool
    - b. Identification of Fiber

Weight Per Unit Area (GSM)

Definition: Fabric has different thickness, which can be controlled with weight per unit area.

Significance: to check the specified fabric for specified purpose.

Procedure:

At Standard Condition

Put the sample for standard condition RH 65 % at 27 ± 2 °C for 2 hours

Cut suitable size away from the selvedge approx 6 “.

Calculation:

Example: Wt of 30.48 x 30.48 cm = X gm

$$\text{Wt of } 100 \times 100 \text{ cm} = \frac{100 \times 100 \text{ cm} \times X \text{ g}}{30.48 \times 30.48}$$

$$\text{GSM} = Y \text{ g}$$

Oven Dry Method

All the procedure as above except wt will be taken after drying in oven till to constant weight

Calculation as method except regain of particular material will be added in total weight.

Allowances Based On the Dry Weight

Material	Percentage of addition to dry weight
Cotton	8.5
Wool	16- 18
Jute	14.25

Count of Threads

Significance: to check the quality /density of cloth.

Procedure:

Normally two methods are used to count ends and picks

By Counting Glass

By using this method number of threads visible within the aperture of standard one inch counting glass is determined. Ends /picks should be found at not less than five different places of fabric. Fabric should be lay down on a flat horizontal surface and place the glass on the fabric so that one of the edges of its aperture to parallel to Ends/Picks and then count.

Magnifying Glass

By Dissection of Fabric

Cut sample about 1 ¼ inch long in the direction at right angles to the threads to be counted. Take at least five specimens selecting then so as to represent the material as fully as possible. Measurement the specimen exactly 1" in width and then count them accurately in the same way all five readings of Ends /Picks.

Count of Yarn

Definition: No of hanks /lbs is called count of yarn

Significance: to check the fineness /quality of yarn/thread.

Procedure:

At present there are different systems of determining the fineness quality of the yarn /thread two of the system for count are as under.

Indirect System (British system)

In this system yarn count is expressed in terms of length or hanks/unit mass (lbs)

For Cotton

Formula: 453.6 x length in yds / 840 x wt in gm

Example: No of thread taken = 20

Length of thread = 18"

Weight of thread = 0.54 gm

Calculation: 453.6 x 10 / 840 x 0.54

= 10^{S}

Working

18x20 /36

= 10 yds

Direct System (Tex System)

In this system yarn count is expressed in terms of mass / unit length

For Cotton

Formula: Wt in gm / length in Km

Example: No of thread taken = 20

Length of thread = 50 cm

Weight of thread = 0.10 gm

Calculation: 0.10 / 0.01

= 10 Tex

Working

50x20 / 1000

= 0.01 Km

Breaking Strength

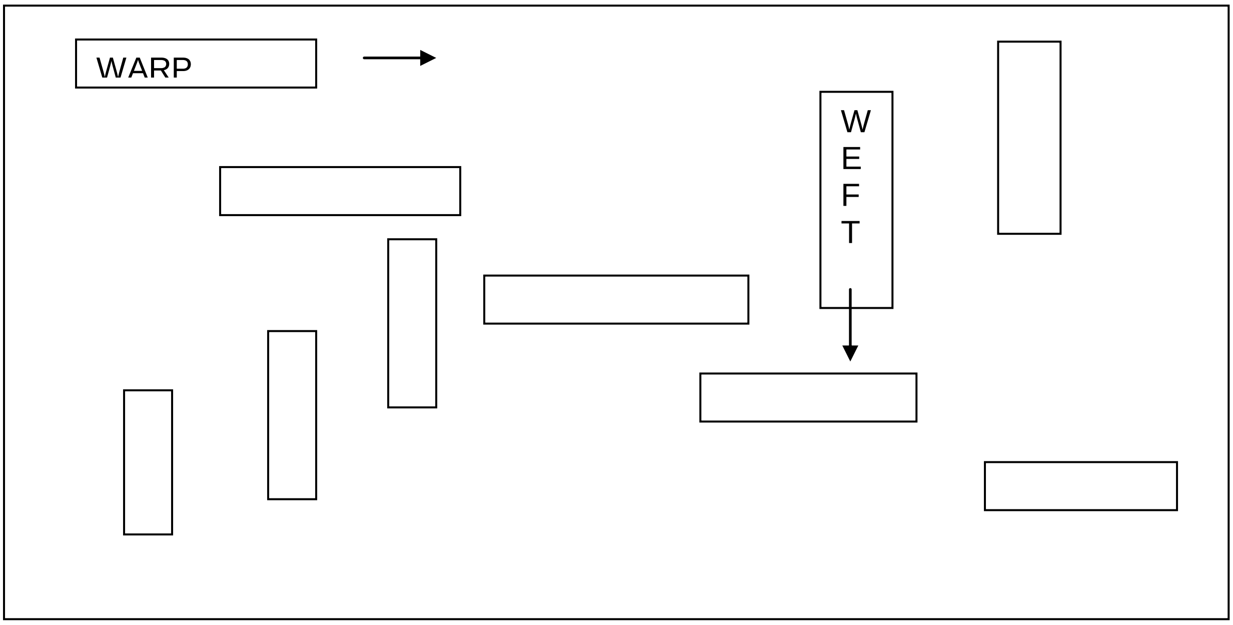
Definition: Maximum load applied to specimen in stretching it to rapture.Breaking strength is express in pound wt or Kilogram wt.

Significance: To check the strength of finished product at standard condition.

Procedure:

1. Put the sample for standard condition RH 65 % at 27 ± 2 °C for 24 hours
2. Prepare 5 x breaking strength pieces diagonally in both directions warp and weft as shown in the diagram.
3. Size of width and between grip as per PPs. B.S
4. Specimens shall be made approx 6 inches away form the selvedge.
5. Specimens shall be made sufficiently little wider than the specified width to allow the necessary fringes.
6. Samples are tested in both warp and weft direction.
7. Fix the specimen in B.S machine perpendicular to jaws.
8. Operate the machine.
9. Note the reading at rapture.

Sampling



Dye Fastness to Washing

Scope: There are series of five washing tests has been established to investigate the fastness to washing of coloured textiles and between them cover the range of washing procedures from mild to sever.

Principle: A specimen of the textile in contact with one or two specified adjacent fabrics in mechanically agitated under specified conditions of time and temperature in a soap solution. Then rinsed and dried, the change in colour of the specimen and staining of the adjacent fabrics are assessed with the grey scales.

Procedure:

1. Place the composite specimen in the container and add the necessary amount of soap solution to give a liquor ratio of 50:1
2. Treat the composite specimen at a temp and time (as per washing test no) as mentioned below.

Type of Washing	**Time** (Min)	**Temp** (^{O}C)	**Soap** (%)	**Na_2CO_3** (%)
Washing - 1	30	40 ± 2	0.5	-
Washing - 2	45	50 ± 2	0.5	-
Washing - 3	30	60 ± 2	0.5	0.2
Washing - 4	90	95 ± 2	0.5	0.2
Washing - 5	240	95 ± 2	0.5	0.2

3. Remove the composite specimen , rinse it twice in running tap water for 10 min and squeeze it. Open out the composite specimen and dry it by hanging it in air at a temperature not exceeding 60 degrees
4. Assess the change in colour of the specimen and the staining of the adjacent fabrics with the grey scales.

Note: Soap used should not contain moisture more than 5 % and shall be entirely free form fluorescent brightness agent. Soap solution contains soap per liter of distilled water.

Wales & Courses Per Inch

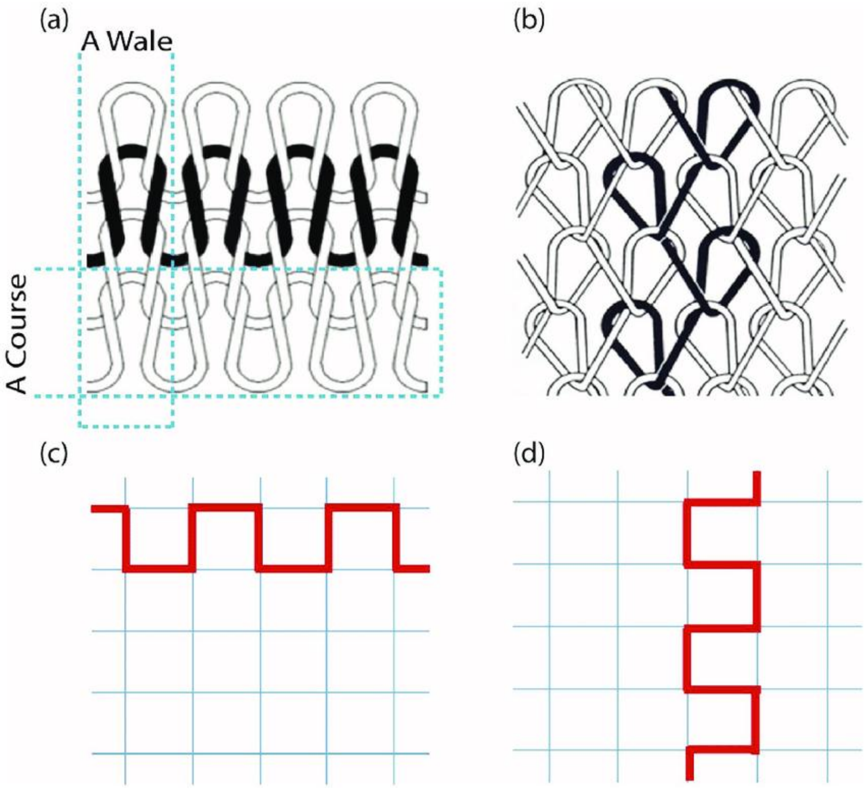
Definitions:

Wale: When the interlocking loops run lengthwise, each row is called wale. A wale corresponds to the direction of warp in woven fabric

Course: When the loops run across the fabric, each row is called course. A course corresponds to the filling or weft in woven fabric

Significance: To check the density of fabric in knitting.

Procedure: The knitted fabric shall be laid down on a table without tension and the Wales and the Courses per inch shall be determined by counting by a magnified glass at a space of not less than 2 inches and at least at 5 different places.



Quality of Wool

Definition: "Fineness of fiber is called quality of wool". If the fiber is thin then the quality will be better and if fiber is thick the quality is poor. There are different grades for quality of wool, these are from 36^S to 80^S.By observing fiber width or diameter. The fiber distribution and number of fibers measurement shall confirm to the specification for grade or fineness of wool tops. The requirement is based on official standard of US for grades of wool tops and shall be the basis for classification of wool tops by grade.

Significance: To check quality of wool as the fine quality of wool provides good thermal insulation and comfort during use.

Procedure: Cut the fiber from different portion of sample to extent of ½ mm, moisture the fiber with few drops of carbon tetra chloride then a few drops of mineral oil on a clean dry slide and scatter the fiber on slide, place the slide on the stage of microscope and measurement width of fiber so that far, near and intermediate areas will be reached. Number of reading depends on quality such as 400 observation for 80^S and 1600 for 36^S.

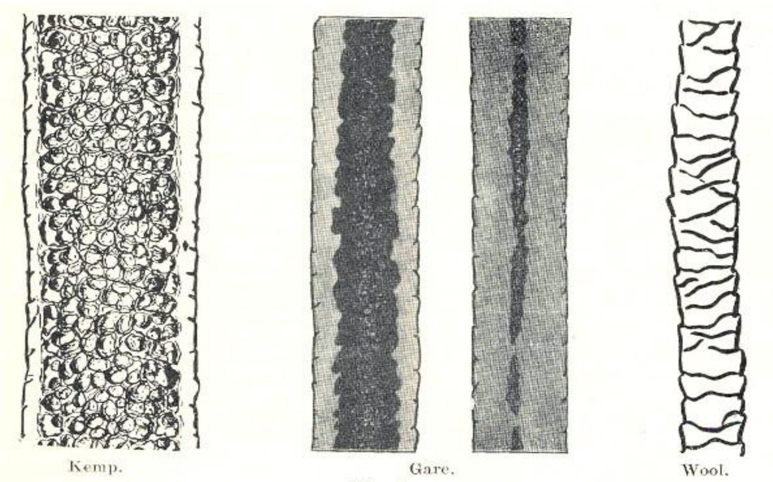


Fig. 1.

Calculation:

Average thickness of the fiber = Microscope factor x sum of reading / No of reading. Average thickness of fiber compare with the quality of wool table for grading.

Grade	64^S	62^S	60^S	58^S	56^S	54^S	50^S	48^S	46^S	44^S	40^S	36^S
Ave Diameter												
Min	21.1	22.6	24.1	25.6	27.1	28.6	30.1	31.8	33.5	35.2	37.1	39
Max	22.6	24.1	25.6	27.1	28.6	30.1	31.8	33.5	35.2	37.1	39	41.3

Identification of Fibers

With the introduction of new yarns & fibers every yarn, their accurate identification become increasingly difficult & more a job for the specialist. The special will know the pitfalls & also know the literature to consult when he is in doubts. There are however, a large number of quite simple tests, which can be carried out in any small laboratory, & if to this added a good Measurement of common sense, most of the more common fibers can be identified with reasonable certainty.

The sample for identification may be received in one of many forms. From the point of view of identifying it, the ideal form is an un-dyed yarn, free from any extraneous matter such as sizes or finishes, & if it is possible to obtain it in this state from the sample, by stripping out the colour, or scouring out the finish, this should be done at first, although even in these operations, there are possible modification which the fiber might undergo & the portion of the original sample should always be returned.

The various tests which can be applied can be clarified under the following heading:-

1. Visual examination
2. Burning tests
3. Staining tests
4. Solubility tests
5. Microscopic appearance

These are given in the order of the case with which they can be applied & not in the order of importance by for the most informative is the cross-section examination, for which a good microscope and a special apparatus is required as, well as knowledge of the characteristics of the various fibers. This is considered of most importance become of the possibility of mixed fibers, which so often give misleading results in burning, staining & solubility tests

1. Visual Examination

This might be alternatively described as a “Common Sense” examination because with only a slight knowledge of yarn & fiber characteristics certain facts can, at this stage_A black bead with a different smell is given when cellulose acetate rayon burns. There is a slight smell of acetic acid but until one becomes familiar with this, yarn known to be cellulose acetate should be used for comparison.

Most of the new synthetic fibers melt or shrink as they approach the flame, forming a colourless bead. The chief ones at the present time are Nylon

& a lesser extent vinyon the head formed on the latter being more irregular than the former. Some have characteristic smells but no different guide can be given, although comparison with known sample in helpful. The melting or shrinking, as they are approached to a flame is characteristic of a new synthetic fibers. Alginate rayon when burnt leaves an ash skeleton unlike that weighted natural silk. Asbestos & spun glass will not burnt but the later will melt & form a bead.

2. Staining Tests

There are many staining tests in the market & consist of mixture of dyestuffs. Different fibers under the conditions of the tests, absorb some of these dyes and enable some distinctions to be made. The most widely used at the present time in this country is shirlastain A, which is marketed by ICI Ltd, The un-dyed fiber freed from extraneous matter is thoroughly wetted with cold water, immersed in the cold stain for one mints and then washed with cold water, The colour obtained with the most common fiber are :-

Cotton	-	Purple
Flax, hemp	-	Different shades of violet, lavender and purple.
Jute	-	Golden brown
Viscose Rayon	-	Bright Pink
Cuprammonium Rayon	-	Bright blue
Cellulose acetate rayon	-	Bright greenish yellow
Nylon	-	Golden yellow

It is worth noting at this stage how these successive tests can gradually identify certain yarns. Consider a sample which on visual examination showed to be a continuous filament yarn and a burning test showed to be cellulose. This is almost certainly either viscose or cuprammonium rayon & shirlastain makes, a ready distinction between the two.

3. Solubility Tests

The different solubility of fibers, due to their different chemical composition, provides an additional means of distinguishing between them and of analyzing mixtures quantitatively. There are many solvents, which could be used, and the following are merely a selection. For quantities estimation on a spun mixtures the solution of one of the components and determination of the loss in the weight is the most widely used method: -

	Chemical	**Dissolve fibers**
a.	Boil 5 % Caustic Potash	Wool, Silk and Hair.
b.	Acetone	Cellulose acetate rayon.
c.	80 % Sulphuric Acid	Cotton ,Silk , Viscose and Nylon
d.	HCl (Con) 30-40 ^{0}C	Silk , Nylon and cellulose acetate
e.	90 % Phenol	Cellulose acetate, Nylon and Polyester
f.	Boiling with Glacial Acetic Acid	Cellulose acetate and Nylon

4. Microscopic Appearance

Much information regarding the identification of fibers can be obtained by an examination under the microscope. Some idea of how variable are the shape of the cross-section of different fibers be obtained from the following.

S.No	Fiber	Microscopic view
a.	Wool	Round or elliptical
b.	Cotton	Collapsed tubular
c.	Silk	Triangular with rounded corner
d.	Bast	Polygonal
e.	Viscose rayon	Very serrated edge

Fiber	Approac-hing flame	In flame	Removed from flame	Odor	Ash
Cotton	Scorches ignites readily	Burns quickly yellow flame	Continues to burn rapidly has after glow	Burning paper	Light feathery grayish
Linen	Scorches ignites readily	Burns slower than cotton if yarns are heavier yellow flame	Continues to burn	Burning paper	Feathery grayish
Wool	Smolders	Small, slow flickering flame, sizzles and curls	Ceases flaming	Like burning feathers or hair	Crisp, dark ash, irregular shape crushes easily

Chapter -17

Textile Care, Storage and Labeling

Textiles have been used in various human endeavors for thousands of years and have the potential to be highly symbolic and culturally important. Great impact on the behavior and deterioration of a textile object, and learning the basic properties of textiles can greatly aid in caring for them. There are three major factors that determine the final characteristics of any textile

1. The fiber form
2. The source of the fiber
3. The method of constructing the final product.

The process of deterioration may begin before the textile even reaches the consumer. Some important factors impact on textile are :-

1. **Light**

   Light can have a dramatic detrimental affect on all textiles as well as some dyes. Both visible light and UV light from sunlight and fluorescent tube lighting have the energy needed to activate chemical reactions that lead to deterioration. The deteriorating effect of light depends on the strength of the light and how long the item is exposed. It takes a surprisingly small amount of light to initiate deterioration.

2. **Humidity**

   High humidity causes fibres to swell and distort changing the shape of the textile object and causing some types of dyes to run or fade. Humid conditions also promote mold, fungus, and insect growth. Low humidity can also lead to damage by causing fibres to shrink and become brittle. Wool is especially susceptible to damage in dry conditions because its natural function is to absorb water

3. **Heat**

   Heat damage manifests itself in brittleness as well as a brown discoloration caused by the products of polymer breakdown. Heat can come from lighting mechanisms that are placed too close to the object as well as from heating systems.

4. **Acids and Alkalis**

   In general protein polymers fibres will tolerate small amounts of acids while cellulose polymer fibres will tolerate small amounts of alkali, but it is best to limit exposure to both.

5. **Preserving Textile Objects**

   There are several techniques that can be used to avoid exposing textiles to the deterioration agents. Many ways of repairing and cleaning textiles also exist however, aside from careful vacuuming, these techniques are not recommended for those who are not trained in textile conservation. Many conservation methods have the potential to damage the textile further. Wet cleaning is a widely used cleaning method, but it is extremely hazardous when done improperly. Loss of dyes or paints, the removal of water-soluble sizes, dimensional changes, and the production of a kind of "textile mud" when highly degraded textiles are exposed to water are among the possible results of wet cleaning.

5. **Vacuuming**

   In some cases, a textile may have surface dirt and dust that can be removed by vacuuming if the textile is not excessively brittle. The advice of a professional is recommended before this is performed to ensure that the textile is stable enough to endure this process. Any textile object that is at a point where small pieces are breaking off

6. **Brushing**

   Brushing is not recommended because it only moves dust around instead of removing it and has the potential to cause damage even when done lightly.

Storage

The overall goal of any storage method should be to protect the object from the agents of deterioration. The particular method chosen for storing any textile should be based on the textile's condition and size, and all materials that come in direct contact with the object should be of archival quality.

Relative humidity should be kept constant at a level between 50 and 60 percent to prevent fibres from expanding and shrinking repeatedly causing dimensional distortion. Rapid changes in temperature should be avoided because they usually cause changes in humidity and because high temperatures can cause heat damage and organism growth. Temperatures of 60 to 68 degrees Fahrenheit (15 to 19 degrees C.) are considered best for textiles. Excess handling and mechanical stresses are another source of damage. This damage can be minimized by limiting the amount of contact between items in storage

Type of Storage

Rolling and flat storage are the two best storage methods

1. **Rolled Storage**

   Rolling is the most space efficient for large textiles that are in fairly good condition. It is important to note, however, that painted textiles should not be stored rolled because the painted areas will or are already stiffened by age. If these types of textiles are rolled, cracking, splitting, and paint loss can occur.

2. **Flat Storage**

   Small textiles (or even fairly large ones, space permitting) can be stored flat in properly lined and sealed metal or wooden drawers. This is also the best storage method for painted textiles. Lighter objects of similar sizes may be stored in a few layers with acid free tissue paper in between items if no mounts are involved.

Labeling of Textile Product

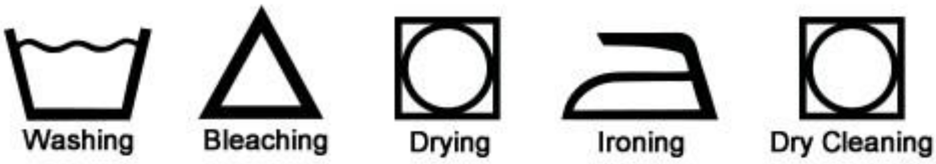
1. **Fiber Labeling**

   Fiber labeling is a mandatory requirement for textile articles in major markets such as USA, Europe, etc. It requires all the textile products to have labels that contain information in respect of fibre content of products, manufacturer or importer identification and country of origin at the point of sale.

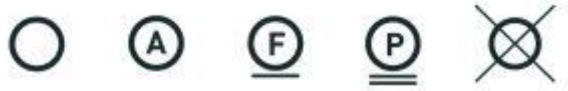
SHAPE
MADE IN CHINA
80% ACRYLIC
20% WOOL
MACHINE WASH COLD
WASH DARK COLORS
SEPARATELY
RESHAPE DRY FLAT
DO NOT BLEACH
DO NOT WRING

2. **Care Labeling**

Care labeling is another mandatory requirement for wearing apparel. Symbols have a specific meaning; each label should state the fabric type and as a minimum include, in order, four symbols: washing, bleaching, drying and ironing. The water temperatures suggested are provided as a guideline.



Dry Cleaning



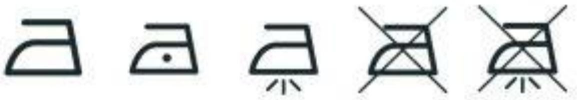
If the care label has a small circle the manufacture is stating you must dry clean this item.

A little letter inside the circle it's indicating to the dry cleaner what chemical to use.

The more bars underneath the circle indicate the level of precaution the dry cleaner must take.

A cross over the circle symbol you should not dry clean the item.

Ironing



Your item can be ironed at any temperature If the care label iron symbol has no dots

The more dots on the iron symbol suggests the temperature of heat that can be applied

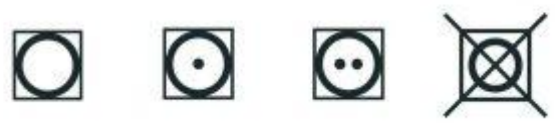
1 dot: delicates i.e. silk and wool.

2 dots: synthetics.

3 dots: linen and cotton.

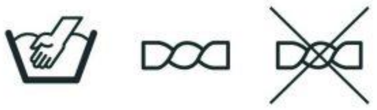
A cross over the iron symbol you should not iron the item.

Drying



Care label has a circle inside a square your item can be tumble dried. The more dots on the iron symbol suggest the temperature of heat that can be applied. If there is a cross over the tumble dry symbol you should not tumble dry the item.

Hand Washing

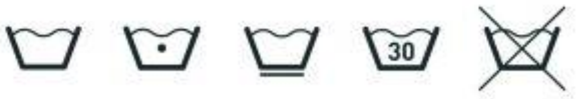


Care label has a tub with a hand your item can be hand washed or put in a delicate washing cycle of 40°C or lower.

Care label has a twisted symbol your item can be wrung.

Care label has a cross over the twisted symbol you should not wring the item.

Machine Washing



If your care label has a tub symbol your item can be washed in the washing machine.

A number on the tub symbol indicates the maximum temperature that can be applied.

The more bars underneath the tub indicates a reduction of spinning and rinsing:

No bars : The item can be spun and rinsed as normal.
1 bar : Spin speed should be reduced.
2 bars : Mild wash ,can be spun and rinsed as normal.

A cross over the tub symbol you should not wash the item.

Trade Mark

1. **Woolmark**

   Woolmark is a globally recognized textile fibre brand and is the guarantee of fibre content and quality specification. Through the licensing of Woolmark, the products can be allowed to use the related brand name Woolmark, Woolmark Blend and Wool Blend.

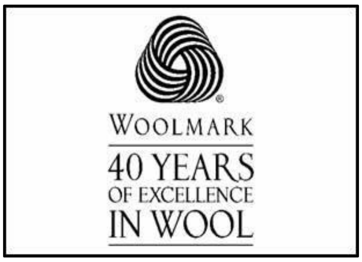
2. **GORE-TEX**

   GORE-TEX is a technology in high-performance windproof,

   waterproof and breathable clothing.

3. **LYCRA®**

   Lycra is a brand name for spandex / elastane. It is widely used in swimwear, underwear, jeans, casual wear, tops, socks and hosiery.



Glossary

A

1. **Abrasion** The wearing away of fiber by rubbing away.
2. **Absorbency** The ability of a fiber or fabric to absorb moisture.
3. **Acetate** Fiber that uses cellulose refined from cotton and/or wood pulp. Characteristics: fast drying, wrinkle- and shrinkage-resistant, crisp or soft depending on end use, luxurious in appearance.
4. **Acid Dye** Applied to protein fabric or fiber from an acid dye solutions. It can be used on nylon, wool and other animal protein fibers, silk, acrylic, polypropylene and blends. It is fairly colour fast to light and laundering.
5. **Acrylic** Fiber made from long-chain synthetic polymers. Characteristics: wrinkle resistance; low moisture absorbency and quick drying; provides warmth yet lightweight, soft and resilient.
6. **Animal Fibers** Protein-based hair, fur, and cocoon materials taken from animals. Typical animal fibers include wool, mohair, llama, alpaca, cashmere, camel and vicuna and cocoon material (silk).

B

7. **Basic Dyes** A class of dyes, usually synthetic, that act as bases and which are actually aniline dyes. Their colour base is not water-soluble but can be made so by converting the base into a salt. The basic dyes, while possessing great strength and brightness, are not generally light-fast.
8. **Basket Weave**-A variation of the plain weave in which two or more threads weave alike in both warp and weft, joined in the regular order of the plain weave. Named for the basket-like pattern of the weave.
9. **Bast Fibers**-Fiber obtained from the stems of certain types of plants. These include flax, hemp, jute, ramie, milkweed, and nettles.
10. **Black Wool**-Any wool containing non-white fibers. A fleece having only a few black fibers is rejected by a grader and goes into the black wool bag because there is no way of separating the few black fibers in the manufacturing processes. Black wool is usually run in lots that are to be dyed.
11. **Black-top Wool**-Wool containing a large amount of wool grease combined at the tip of the wool staples with dirt, usually from a Merino. This wool is usually fine in quality, of good character, and desirable in type, but the shrinkage is high.
12. **Bleaching**-The procedure, other than by only scouring, of improving the whiteness of textile materials. Sometimes accomplished with and sometimes without the removal of natural colouring or other extraneous substances.
13. **Bleeding**-A term applied to yarn from which the colour runs, usually staining the white or lighter coloured-items nearby.
14. **Blends**-A textile containing two or more different types fibers or different colours and grades of the same fiber.
15. **Breath-ability**-The movements of water or water vapor from one side of the fabric to the other, caused by capillary action, wicking, chemical, or electrostatic action. Also known as moisture transport**.**

16. **Broken End –** In woven fabrics avoid in the warp direction due to yarn breakage.

17. **Broken Pick –** In woven fabrics a discontinuity in he filling direction caused by break or cut in the filling yarn.

C

18. **Canvas**-A general classification of strong, firm, closely woven fabrics usually made with cotton. A heavier, open weave comprised of plied yarns. Characteristics: very hard-wearing, generally water-resistant.

19. **Cellulose**-A polymer found in organic woody substances of most vegetation. It is the basic rw material needed for production of rayon and acetate fibers.

20. **Clean Wool**-Usually refers to scoured wool but occasionally it describes grease wool that has a minimum amount of vegetable matter.

21. **Clo Value**-A unit of thermal resistance.

22. **Coarse Wool**-Wool that has a Blood grade of 1/4 or Common or a numerical count grade of 44's, 45's, or 48's, OR a micron count above 31. Coarse wool may have as few as 1 to 5 crimps per inch.

23. **Colour Fastness**-The term used to describe the resistance of fabric to the loss of colour. There are several things which can cause loss of colour, the most important being washing and light.

24. **Combed fibers**-Fibers that have combed. This process removes the short fibers. When drawn off, the fiber is called "top".

25. **Combing**-An operation in the worsted system of fiber preparation that removes the short fibers and foreign impurities. The long fibers are straightened and laid parallel.

26. **Cotton**- A vegetable fiber consisting of unicellular hairs attached to the seed of the cotton plant. Most cotton is coloured a light to dark cream, and its chemical composition is almost pure cellulose. A distinct feature of the mature fiber is its twist.

27. **Cotton Count**-The cotton count expresses the number of hanks required to make a pound of yarn. A hank of cotton is equal to 840 yards. So 1 cc = 840 yards of cotton, the coarsest cotton yarn. A 3 cc yarn would then be one-third as course and would be expressed as 3/1 cc show that it is a single strand. Likewise two numbers separated by a slash such as 4/2 cc designate plies. This equals 3360 yards (4 x 840) of two-ply yarn. This yields 1680 yards of yarn per pound (3360/2). An 8/4 cc yarns would yield the same number of yards per pound, but would be a 4 plies of finer yarn. So a Number 8 four-ply yarn is the same diameter as a Number 4 two ply yarn.

28. **Count-**The number given to a yarn of any material, usually indicating the number of hanks per pound of that yarn. May also refer to the fineness

29. **Crocking**-The name given to when excess dye rubs off from fibers.

30. **Crinkle**-The waviness of each individual fiber when separated from a lock. It is responsible for elasticity and is usually irregular.

31. **Crocking-**The transfer of dye stuff from one fabric to another item by friction. This usually happens when a fabric or yarn has been over dyed.

32. **Cropping**-The process of cutting the pile on a fabric to uniform height or cutting loose fibers from the surface of a cloth after weaving.

D

33. **Denier**-A unit of weight indicating the fineness of fiber filaments and yarns, both silk and synthetic, and equal to a yarn weighting one gram per each 9000 meters; used especially in indicating the fineness of women's hosiery. The abbreviation for this is "d" or "D".
34. **Denim-**A well-known basic cotton or blended fabric in a right- or left-hand woven twill. Generally, the warp is dyed blue with a weft.
35. **Density**-An index of the number of wool fibers per unit of a sheep's body. Fine-wool breeds show greater fleece density than the coarser wool breeds.
36. **Direction of twist**- The direction of twist in the yarns and other textile strands is indicated by the capital letter S or Z.
37. **Direct Dyes**-A class of aniline dyes, so called because they have such great affinity for cellulose fibers, i.e., cotton and linen. While both these and acid dyes are sodium salts of dye acids, direct dyes do not require the use of a mordant. Their shades are duller than those of either acid or basic dyes and they tend to have less tinctorial value than the basic dyes; however, they have the very important advantages of being much more lightfast than the basic dyes and possibly more so than acid dyes.
38. **Direction of Twist**-(S twist or Z twist) To determine twist, hold yarn in a vertical position and examine the angle of the spiral. The angle of the S twist will correspond to the center portion of the S. The angle of the Z twist will correspond to the center portion of the Z. When spinning, the wheel should rotate counter clockwise for an S twist and rotate clockwise for a Z twist.
39. **Drape**-The way a fabric hangs. Yarns, weave structure, and finish affect drape.
40. **Durability**- The ability of a fabric to resist wear through continual use.
41. **Dye** -There are many application classes of dyes, including acid dyes, disperse dyes, reactive dyes, and natural dyes. Dyes may be generally divided into natural and synthetic types. Natural, or vegetative, dyes are obtained from berries, flowers, roots, bark and more. Synthetic dyes are chemical compounds.
42. **Dye ability**-The capacity of fibers to accept dyes.
43. **Dye bath** -The solution (usually water) containing the dyes, dyeing assistants and any other ingredients necessary for dyeing.
44. **Dyeing** -The process of applying a comparatively permanent colour to fiber, yarn or fabric by immersing in a bath of dye.

E

45. **Elasticity**-The ability to return to its original length after being stretched or compressed. Wool has more elasticity than cotton, with finer wools hstretching up to 30% of their original length.
46. **End**-A warp yarn.

F

47. **Felt-** A non woven /knitted fabric**.**
48. **Fabric**-Any cloth woven or knitted from fibers.

49. **Fiber**-The fundamental component used in making textile yarns and fabrics. Fibers are fine substances with a high ratio of length to thickness. They can be either natural or synthetic (man-made). Natural fibers are of animal origin (wool, mohair, etc.) or vegetable origin (cotton, linen, etc.) or mineral origin (asbestos). Synthetic fibers are produced from naturally occurring material, mainly wood pulp or cotton lint, and the most commonly used example of this form of fiber is rayon. Manmade fibers are produced directly by the polymerization of synthetic chemicals at present obtained as by-products of the petro-chemical industry: typical examples are nylon and polyester.

50. **Fiber Fineness**-The mean fiber diameter which is usually expresses in microns.

51. Fiber Length-The staple length of the fiber. On combing wools, this is often 3-8 inches, on the down wools 1.5-3 inches. With cotton, it may be 1/4-1 inch long. Bast fibers, likes flax, may have a staple length of 36 inches.

52. **Fiber Thickness**-The average diameter of the fiber.

53. Filament-A fiber of indefinite or extreme length, some of them miles long. Silk is a natural filament, while nylon and polyester are synthetic filaments. Filament fibers are generally made into yarn without the spinning operation required of shorter fibers, such as wool and cotton. Filament yarns are smoother and more lustrous than spun yarns.

54. **Fine Wool**-The finest grade of wool -- 64's or finer, according to the numerical count grade OR wool with an 18 to 24 micron count. Also, the wool from any of the Merino breeds of sheep. Fine wools may have as many as 30 crimps per inch.

55. **Finishing**-This refers to additional steps used after the yarn is removed from the bobbin.

56. **Flame Retardant**-Any process which can improve the resistance of a fabric to burning.

57. **Flammability**-The ability of a textile to burn under specified test conditions.

58. **Flannel**-Traditionally, an all-wool fabric of plain or twill weave with a soft handle.

59. Flax-A slender, erect, annual plant (genus Linum having narrow, lance-shaped leaves and blue flowers, cultivated for its fiber and seeds. The fiber of this plant, manufactured into linen yarn for thread in woven fabrics.

60. **Fleece**-The wool from one sheep, either as it comes from the animal or after it is rolled into a bundle and tied.

G

61. **Gray Wool**-Fleeces with a few dark fibers, a rather common occurrence in the medium wools produced by down or black-faced breeds.

H

62. **Hair Fibers**-Wool-like fibers from animals other than sheep, including the alpaca, llama, vicuna, cashmere goat, angora goat, angora rabbit and Bactrian camel.

63. **Hank**-A package of yarn from a reel, hopefully with the yardage and fiber content noted on a label. This may refer to a specified yardage, as in a hank of

worsted yarn contains 560 yards, cotton and silk is 840 yards, and linen is 300 yards.

64. **Heat Setting**-The process of conferring stability upon fibers, yarns, or fabrics by means of steam or dry heat.

65. **Hemp**-The fiber from the plant Cannabis sativa.

66. **Herringbone Twill**-A broken twill weave composed of vertical sections, which are alternately right hand and left hand in direction. The twill changes direction perfectly where the weave breaks, balancing the overall pattern of the fabric.

67. **Hue**-The pure spectrum colours commonly referred to by the "colour names" - red, orange, yellow, blue, green violet.

I

68. **Indigo** - A blue dye from a variety of plants in the Indigo era family. Commonly used as a vat dye on both cellulose and protein fibers.

J

69. **Jute**-A vegetable bast fiber often used for basketry and course weavings.

K

70. **Kapok**-A vegetable seed fiber from the Kapok tree.

71. Kemp-A white, straight, opaque, coarse, non-felting, in-elastic fiber having a thick central medulla with hollow inter spaces. It will not take a dye; hence, its presence in wool is most objectionable. Often found around the head and legs.

L

72. **Lamb's Wool**-Wool shorn from lambs, usually when they are less than 7-8 months old. It is soft and has spinning qualities superior to fleeces of similar quality produced on older sheep.

M

73. **Man-Made Fiber**-A man-made fiber, e.g., viscose, rayon. Also known as "manufactured fiber".

74. **Mercerization**-A treatment of cotton yarns or fabrics with caustic alkali, in which the fibers are swollen and stretched to increase the luster in the finished product.

75. The hollow, rounded cells which are found along the center of the main axis of a fiber. They may run continuously along the length of the fiber.

76. **Mercerizing** -Treatment used to increase luster and improve strength and dye affinity in cotton. The treatment consists of impregnating the fabric with cold concentrated sodium solution. Invented by John Mercer.

77. Micron-A micron is 1/25,400 of an inch. The most accurate way of determining wool grades.

N

78. **Nap**-Soft, fuzzy surface produced on a fabric by brushing it to raise the fiber.

79. **Natural Dye**-Dyes obtain from natural sources.

80. **Napping**-The process of raising fibers from the base structure of a fabric or felt.

81. **Natural Dye**-Dye obtained from substances such as roots, bark, wood, berries, lichens, insects, shellfish and flowers.

82. **Natural Fiber**-Fiber obtained from animal, vegetable or mineral sources, as opposed to those regenerated or synthesized from chemicals. Please see Synthetic Fiber.

83. **Naps**-Small knots of tangled fiber, usually consisting of short, dead or immature fiber, or caused by over-processing.

84. **Nylon**-The generic term for man-made fibers composed of polyamides derived from coal and petroleum. Characteristics: high strength, elasticity, low water absorption and quick-drying.

P

85. **Pilling**-The tendency of some yarns to form little balls of short, tangled fibers on the surface. This tendency can be reduced (or removed) by removing the short fibers (combing) or by adding additional twist.

86. Plied Yarns-Yarns produced by two or more singles have been twisted together.

87. Ply-A single unit of yarn. A 2-ply yarn would involve taking two singles and then plying them in the opposite direction they were originally spun. See "S-twist" and "Z-twist".

88. **Polyester**-A manufactured fiber made from long-chain synthetic polymers. Characteristics: crease-resistance, quick-drying, great shape retention, high strength, abrasion resistance and easy care.

89. **Protein Fiber**-A fiber composed of protein, including such naturally occurring animal fibers as wool, silk, alpaca, llama and other hair and fur fibers.

90. Pulled Wool-Wool pulled from skins of slaughtered sheep. The wool is pulled from the skins after treatment of the fleshy side of skins with a depilatory. Pulled wool should not be confused with "dead wool".

Q

91. **Quilting** – A fabric construction in which a layer of down or fiberfill is place between two layers of fabric, and then placed by stitching or sealing in a regular consistent, all-over pattern on the goods.

R

92. **Raw Silk**-Continuous silk containing no twist that has been drawn off of cocoons. The fibers are often un-degummed.

93. **Reclaimed Wool**-Wool that is reclaimed from new or old fabrics.

94. **Regenerated Fiber**-These are fibers created by modified natural fibers. The cellulose regenerated fibers include rayon and acetate. The protein-regenerated vegetable fibers include soybean (soylon), peanut (ardil), and corn (vicara). The protein-regenerated animal fibers include casein (aralac), gelatin, and albumin.

95. **Resilience-**The power of recovery to original shape and size after removal of the strain which caused the deformation. A fiber may possess this quality to spring back to its original state after being crushed or wrinkled. Resilience is sometimes referred to as memory.

S

96. **S-Twist**-Spinning clockwise. Traditionally, this is the direction "singles" are spun. If your singles have been spun S-twist, you would ply Z-twist, and then cable S-twist.

97. **Selvedge** The narrow edge of woven fabric that runs parallel to the warp. It is often made with stronger yarns, or in a tighter spacing, to prevent raveling. A fast selvedge encloses all of the picks. a selvedge is not considered fast when the filling threads are cut at the fabric edge after every pick.

98. **Silk** The product of the silkworm. The cocoon thread is of indefinite length but exceedingly fine and lustrous. Continuous protein filament produced by the larvae of various insects, especially the caterpillar when constructing its cocoon. Characteristics: resiliency, aesthetics, elasticity and strength, warm in winter, cool in summer.

99. **Sisal** A vegetable fiber that is made into strong, coarse twine. It is used for binder twine, but should not be used to tie fleeces.

100. **Snarls** Small, curly or 'kinked' places in yarns.

101. **Spindle** According to the dictionary, "A rounded rod, usually of wood, tapering toward each end, used in hand spinning to twist into thread the fibers drawn from the mass on the distaff, and on which the thread is wound as it is spun.

102. **Spinning** The process of making yarn by drawing out, twisting, and winding fibrous substances into yarn or thread.

103. **Staple** A cluster or group of wool fibers naturally clinging together in the fleece.

104. **Staple Length**-The length of sheared locks obtained by measuring the natural staple without stretching or disturbing the crimp. The fiber re-growth or regeneration from one shearing to the next.

105. **Strength**-This refers to the how much weight the fibers can bear. Some fibers, like flax, actually get stronger when wet.

106. **Synthetic Dye** A complex colourant derived from coal tar.

107. **Synthetic Fiber** Synthetic fibers are organic compounds of high molecular weight and are formed by polymerization. Synthetic fibers formed by condensation reactions include polyamides (nylon) and polyesters (Dacron). Synthetic fibers formed by addition reactions include vinyl’s, acrylic-vinyl, acrylic-nitril, and urethane.

108. **Spinning** The spinning process where the twist is not allowed into the drafting triangle. They are usually plied yarns, and are finer and more tightly twisted than woolen yarns.

T

109. **Top** A continuous untwisted strand of wool fibers of predetermined length from which the short fibers have been removed in the combing process..

110. **Virgin Wool** Wool that has been clipped from a live sheep and that has not been previously processed to the stage where it contains twist. Noil is merely separated from long fibers in combing and is considered virgin wool.

111. **Tear Strength** The force necessary to tear a fabric.

W

112. **Warp** The yarns that run the length of the loom. The warp yarns are pulled through the loom as the weft or filling yarns are woven across the warp to make the fabric.

113. **Warping Reel** A rotating frame that can be mounted horizontally or vertically. It's used to wind a warp and help keep the threads in order.

114. **Weft** The set of threads which crosses the warp at right angles. Depending on the use, there may be more than one weft used: ground weft, pattern weft

115. **Woolen Count** The woolen count is based on 1,600 yards of yarn per pound. With woolen yarns, this is called a "run", so a "2 run" would refer to a 3200 yards

116. **Wicking** Dispersing or spreading of moisture or liquid through a given area by capillary action in a material.

117. **Worsted Count** The worsted count also expresses the number of hanks required to make a pound of yarn. A hank of worsted wool is equal to 560 yards. So 1 wc = 560 yards of cotton, the coarsest worsted yarn. Worsted sizes are expressed the reverse of cotton sizes. A two-ply number 6 worsted yarn would be expressed as 2/6 wc and would yield 1680 yards per pound.

118. **Worsted Spinning System** A system of yarn production designed for medium or longer wools, and other fibers. The process includes, opening, blending, cleaning, carding, followed by combing, drawing and spinning. These yarns are compact, smooth and more even and stronger than similar yarns spun using the woolen system.

Y

119. **Yardage** Any fabric made and sold by the yard.

120. **Yarn** A continuous strand of textile fibers that may be composed of endless filaments or shorter fibers twisted or otherwise held together. Yarn is characterized by its composition, its thickness (or grist or count), number of strands (or plies), direction and degree of twist, and the colour.

121. **Yarn Dyed** A term applied to yarns dyed after spinning.

UNIT 2 - LEATHER

Chapter -1

Hide and Skin

Hide and skins are normally available as cured raw materials, the curing being carried out in order to prevent bacterial attack and disintegration. Commonly used raw materials are obtained from the following sources:

1. Bovine Animals
    a. Male - Bull, Ox, Steer
    b. Female - Cow, milk-cow
    c. Middle - Kip, yearling
    d. Veal - Calf
2. Buffaloes
3. Horses
4. Goats
5. Sheep’s
6. Pigs
7. Deer
8. Kangaroos
9. Marine Stock - Seals, sharks, whales, turtles
10. Reptiles - Snakes, alligators, lizards

Structure of Hide and Skin

An animal’s skin is composed of epidermis and dermis. The epidermis is the outermost layer of the skin and is composed of the stratum granulosur. The dermis is the true skin and constitutes the leather making material of the skin. The dermis is composed of the papillary layer which forms the grain’s surface. One way of seeing the structure is to examine a cross-section of the skin, starting form the hair side.

Epidermis

This layer is seen on the surface of the skin. It is made up of cells called keratinocytes, which are stacked on top of each other, forming different sub-layers. The keratinocytes develop at the bottom and rise to the top, where they are shed from the surface as dead cells. So this layer is constantly renewing itself, the live cells changing into dead, hard, flattened cells. Melanocytes and Langerhans cells are other important cells found in the epidermis, which have special functions

Dermis

The dermis consists mostly of connective tissue and is much thicker than the epidermis. It is responsible for the skin's pliability and mechanical resistance and is also involved in the regulation of the body temperature. The dermis supplies the avascular epidermis with nutrients by means of its vascular network. It contains sense organs for touch, pressure, pain and temperature (Meissner´s corpuscles, Pacinian corpuscles, free nerve endings), as well as blood vessels, nerve fibers, sebaceous and sweat glands and hair follicles.

Subcutaneous Layer

The subcutaneous layer below the dermis consists of loose connective tissue and much fat. It acts as a protective cushion and helps to insulate the body by monitoring heat gain and heat loss. Not all authors consider this layer a part of the skin, but it definitely has a strong impact on the way the skin looks.

Hide and Skin

Leather is obtained form the skin or hide of animals.

The term Hide is used for mature, fully-grown large animal such as cowhide, horsehide and OX hide. The term Skin is used for mature, fully-grown smaller animal such as sheep, goat lamb etc.

Composition of Hide and Skin

Fresh Hide and Skins consists of water, protein, fatty materials and some mineral salts. Of these, the most important for leather making is the protein. This protein may consist of many type the important ones are collage which on tainting gives leather. Composition of freshly-flayed hide is as follows:

1.	Water	64%
2.	Protein	33%
3.	Fats	02%
4.	Mineral salts	0.5%
5.	Other substances	0.5%

Cattle Hide

These rawhide represent about 65 % of worlds leather production. All provenances and qualities of cattle hide are used for production of leather i.e. calf, heifer, cow, steer, bull, ox as well as buffalo. The hide’s thickness of 3-15 mm and the available quantities make it the preferred technical leathers.

Sheep Skin

Representing about 17% of world’s leather production. The raw skins of these species offer and enormous variety of different skin structures. Beside meat, the main product of sheep farming is wool. Sheep skins are used for articles which do not require high physical properties like tear and tensile strength, i.e. garments lining, bookbinding leather

Goat Skin

About 9% of worlds leather production is covered by goat skins having thickness 1-2 mm are similar to sheep skins, the structure of goat skins is very much firmer. Therefore goat skins are suitable for articles which demand distinct physical properties i.e. shoes, garments, protective clothing, lining and leather goods

Lamb Skin

This is very soft luxurious leather. Its natural lightweight layers give it a distinctive, velvety touch, which suites form fitting jackets, pants, skirts as well as coats. Lambskin is very wearable and the ultimate luxury.

Cow Hide

This is the most common leather used in the making of garments, furniture and leather goods. Cowhide generally, it is quite durable, easy to care for and resistant to water and dirt. Cowhide leather will maintain its integrity, taking on the shape of the wearer, making it more comfortable with everyday use.

Buffalo Hide

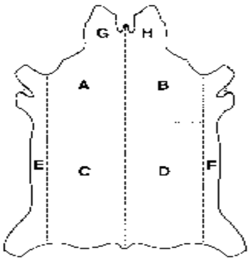
Buffalo hides are as **durable** as **cow hides**, which makes them useful for a variety of purposes. Like cow leather, buffalo leather lends itself well to boots, coats, handbags, and other **durable** items. The strength of the buffalo hide depends on the thickness and grade of the buffalo leather.

Downgrading of Hides and Skins

The value of hide or skin depends on the value of the leather that can be made form it. The following table gives the some indication of the downgrading of the value of hides due to faults.

S.No	Fault	% Loss in value
1.	Belly	3
2.	Belly & butt	6
3.	Grains and flesh of belly	10
4.	Bucher cut	9

Parts of Hide and Skin

	• Double Shoulder A + B • Belly E or F • Double Butts C + D • Bends C or D • Side G+A+C+E or B+D+F+H • Full Hide - All of the above parts

Chapter – 2

Leather

Leather is a durable and flexible material created via the tanning of rawhide or skin of animals. It can be produced through the manufacturing process, ranging from cottage industry to heavy industry.

History of Leather

Animal hides provided and important source of clothing for prehistoric humans. Animal's hides were also frequently believed to be used for shelter by old age people. Hides were also used for shelters storage of water. Animals hide have always been used a status symbol. Fur was used to demonstrate wealth, both by ancient kings and modern people. Natural leather is used in many expensive products, including limousines and designer mobile phones.

The Benefits of Leather

Leather is an extremely versatile material. It is warm in the winter and cool in the summer. Leathers excellent insulation characteristics allow both ventilation and evaporation to take place. There is almost no other clothing material that will provide the service and durability.

Types of Leather

Following are the common types of leather

1 **Full Grain Leather**

Full grain leather, which has not separated upper grain and split layer separated. Full grain referred to that have not been sanded, buffed or snuffed. The grain remains the allowing the fiber strength and durability. The grain also has breath ability, resulting in less moisture from prolonged contact, rather than wearing out. Full grain leather is typically available in two finish type: Aniline and semi-aniline.

2 **Top Grain Leather**

Top grain leather is the second-highest quality and has had the split layer separated away making it thinner and more pliable than full grain. Its surface has been sanded and finish coat added to the surface which results in a colder plastic feel with less breath ability and will not develop natural patina. It is typically less expensive, and has grater resistance to stain the full-grain leather so long as the finish remains unbroken.

3 **Corrected Grain Leather**

Leather is any leather that has had an artificial grain applied to its surface .The hides used to create corrected leather do no meet standards for use in creating vegetable –tanned oraniline leather .The imperfections are corrected or sanded off and an artificial grain impress into the surface addressed with stain or dye. Most corrected grain leather is used to make pigmented leather as the solid pigment helps hide the correction or imperfections. Corrected grain leathers can mainly be bought as two finish types: semi-aniline and pigmented.

4 **Split Leather**

Split leather is created form the fibrous part of the hide left once the top-grain of the rawhide has been separated from the hide. During the splitting operation, top grain and drop split are separated. The drop split can be further split into a middle split and flesh split .In very thick hides, the middle split can be separated into multiple layers until the thickness prevents further splitting. Split leather then has an artificial layer applied to the surface of the split and is embossed with a leather grain. Splits are also used to create suede leather.

5 Suede Leather

Suede is made either from grain leather or from split leather. Inside out grain leather suede is has been designed into the leather article with the grain facing away from the visible surface.

6 True Leather

The following are not true leathers, but contain leather material. Depending on jurisdiction, they may still be labeled as “Genuine Leather”

a Bonded Leather

To 100% leather fibers (often scrap from leather tanneries or leather workshop) bonded together with latex binders to create a look and feel similar to that of leather at a fraction of the cost. This bonded leather is no as durable as other leathers, and is recommended for use only if the product will be used infrequently. Bonded leather upholstery is vinyl upholster that contains about 17% leather fiber in its backing material. The vinyl is tamped is more environmentally friendly the leather production bonded leather or reconstituted leather is composed of 90%.

b. Bycast Leather

Is split leather with a layer of polyurethane applied to the surface and then embossed. Bycast was originally made for the shoe industry and recently was adopted by the furniture industry. The original formula created by Bayer was strong but expensive. Most of the bycast used today is very strong and durable product. The result is slightly stiffer product that is cheaper than the top grain leather but has a much more consistent texture and is easier to clean and maintain.

Leather Manufacturing

There are many varieties of leather used in a variety of apparel and non-apparel products. One cannot think of riding a bike without a leather jacket or leather paints combined with leather gloves on a cold wintry night, leather footwear, accessories like belts bags, wallets upholstery for sofas, automobile seats, engine gaskets and harness.

Making of leather is very different form that of the others and its interesting to know this very ancient art of leather making which is being refined with time.

All kinds of leathers have to pass through three main stages viz-preparatory processes, tanning and finishing process. Some time surface coating is also applied to certain kinds of leathers.

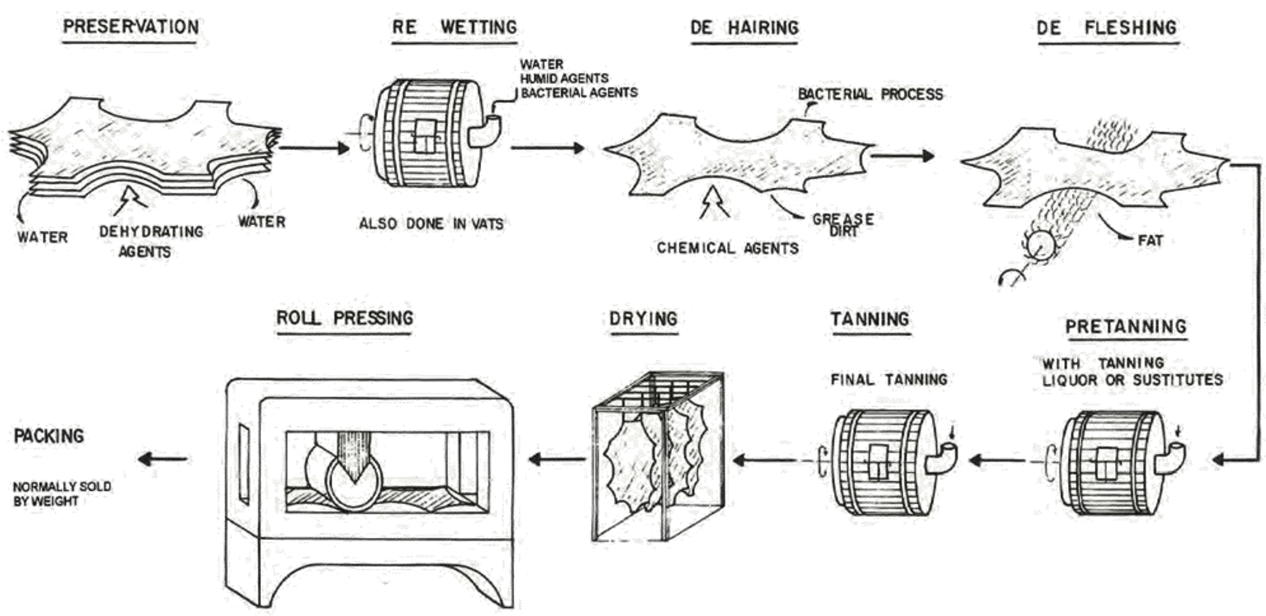
Leather Manufacturing Process

When the hide or skin is prepared for tanning, it has to go through following process.

1.	Flaying	Removing the skin from the animal
2.	Pickling	The raw hide is cleaned and soaked in acids or salts to prevent decompositions.
3.	Soaking	After reaching the tannery, it is soaked in water to restore

		moisture lost during salting
4.	Liming	It is then soaked in lime solution for removing hair,inter-fiberillary protein and epidermis
5.	Flashing	Mechanical instruments like rollers and blades are used to remove fat, muscle and flesh from the middle layer, and innermost fatty layer's these layers are separated or split to obtain the corium from which the leather is made.
6.	De-liming	The hid is washed in a mixture of water and ammonium chloride or ammonium sulphate to neutralize
7.	Bating	The hide is treated with digestive enzymes to remove non-fibrous proteins
8.	De- greasing	Lipases are used to dissociate fat particle set in the skin.
9.	Bleaching	The hide is made colorless by applying chemicals
10.	De-pickling	The hide is put in sulphuric acid to lower the P^H
11.	Tanning	Tanning is the process of taking raw cattle hides that are in Perishable state and putting them into a preserved state. Hides at this stage are light blue in color(Wet blue)and have an unlimited shelf life.
12.	Finishes	After tanning the leather undergoes different finishing process that may include drying, softening, lubricating, dyeing and coloring. For smooth finish, the leather may be treated with waxes, shellac or emulsified synthetic resins, dyes, and pigments. Some time coating is also applied as per the requirements

The Process



However from manufacturing point of view there are 5 basic steps for making of leather.

1. **Selecting**

   The primary distinction between leather types is the quality the hide prior to tanning .The quality is determined by the age, geographic origin and diet of the animal.

2. **Curing**

   Curing is the initial protective treatment that is administered to pelts .It only preserves the hides prior to changing them to leather. The most common methods use salt as the principal curing agent.

3. **Tanning**

   Tanning is the process, which converts the protein of rawhide or skin into stable material, which will not putrefy and is suitable for a wide variety of end applications. The principal difference between raw hides and tanned hides is that raw hides dry out to form a hard inflexible material that re-wetted putrefy, while tanned material dries out to a flexible form that does not become putrid when wetted back. Manny different tanning methods and material can be used: the choice is ultimately dependent on the end application of the leather, The most commonly used tanning material is the highly-polluting leaves the leather, once tanned, a pale blue color, this product is commonly called " **wet blue** ".

   The hides once they have finished pickling will typically be between P^H 2.8 to 3.2. At this point, the hides would be loaded in drum and immersed in a drum and immersed in a float containing the tanning liquor. The hides are allowed to soak and the tanning liquor slowly penetrates through the full substance of the hide. Regular checks will be made to see the penetration by cutting the cross-section of a hide and observing the degree of penetration.

   Once a good, even degree of penetration exist, the P^H of the float is slowly raised in process called basification. This basification process fixes the tanning material to the leather and the more tanning material fixed, the higher the hydrothermal stability and increased shrinkage temperature resistance of the leather. The P^H of the leather when chrome tanned would increased shrinkage temperature resistance of the leather typically finish somewhere between 3.8 and 4.2. There are several tanning processes transform hides and skin into leather. Common tanning process are

   a **Vegetable- Tanned Leather**

   Is tanned using tannin and other ingredients found in vegetable matter, tree bark, and other suck sources? It is supple and brown in color, with the exact shade depending on the mix of chemicals and color of the skin. It is the only form of leather suitable for use in leather carving or stamping. Vegetable-tanned leather is not stable in water: In hot water, it will shrink drastically and partly gelatinize, becoming rigid and eventually brittle. Boiled leather is an example of this where the leather has been hardened by being immersed in hot water, or in boiled wax or of this where the leather has been hardened by being immersed in hot water. Historically, it was occasionally used as armor after hardening, and it has also been used for bookbinding.

   b. **Chrome Tanned Leather**

Chrome-tanned leather is tanned with chromium sulfate and other salts of chromium. It is more supple and pliable than vegetable-tanned leather, and does not discolor or lose shape as drastically in water as vegetable-tanned. It is also known as wet-blue for its color derived from the chromium. More esoteric colors are possible using chrome tanning.

c. **Synthetic Tanned Leather**

Is tanned using aromatic polymers such as the novolac. This leather is white in color and was invented when vegetable tannins were in short supply during the Second World War. Melamine and other amino functional resins fall into this category as well and they provide the filling that modern leather often required.

4. **Dyeing of Leather**

This is the first step in introducing color to the hides, the dye has the same effect on the hide as a stain has on wood. The hide is soaked in a solution of dye until the color has penetrated all the way through. This synthetic dye, a color that has no solids. A purely dyed hide will have very natural look. With no solid, the color varies through the hide and is darker in some areas than others. Also dye allows all of natures marks to be visible. Some leather gets all of it color from dye.

5. **Finishing**

A slight coating of color, with the solids, is put onto the hide to create a more consistent look and even coloration. This coating provides many positive and practical characteristics, Color is put on top of a dyed hide of similar color, the color achieved during dying acts as primer for the finish, This allow less coating to be put on the hide, resulting in a softer hide.

Chapter – 3

Dyeing & Finishing of Leather

Leather is coloured to improve its appearance, to make it adaptable for fashion styling and ultimately, to increase its value as a commodity. colour ranks equally with break, feel temper factors by which most leather is evaluated. the natural and synthetic dyes, pigments, and combinations of pigments and dyes.

Colouring is thus closely integrated with finishing. Leather may be coloured by drum dyeing, or by corrected to shade in finishing, as with shoe leather, or the final shade as in suede leather.

Chrome leather varies in colour bluish gray to greenish gray a weak neutral colour entirely lacking in aesthetic appeal. For a more attractive appearance, chrome leather can be readily bleached to produce a white leather, or coloured with natural or synthetic dyes. Because of its neutral tone, the range of colours that can be applied to chrome leather is almost infinite.

Classification of Leather Dyes

Dye suitable for leather colouring may be grouped into anionic and cationic types. Anionic dyes ar alkali salts or dye acids, cationic dyes (known as basic dye) are the acid salts of dye bases.

Dyes are classified as follows:

1. Acid dyes
2. Metallised dyes
3. Mordant dyes
4. Direct dyes
5. Basic dyes
6. Developed dyes

Methods of Appling Dyes to Leather

Dyes are applied to leathers in drum, paddles or trays and by brush or spray. Drum and spray dyeing constitute the major means of applying dyes to leather.

Finishing of Leather

In finishing problems and suggestions on how to overcome them will be dealt with. In finishing things that affect leather quality badly are encountered time and again for various reasons. Finishing process apply as per requirement of the consumers.

Leather finishing needs considerable artistic experience, together with some background knowledge of chemicals and machinery, because the selection of suitable colours and adjustment of fashion is not easy. It requires a comprehensive understanding of the market. To finish leather, many kinds of binders and solvents are used with due consideration of the durability of the finished product. Finishing system is according to type of leather desired but basically the purpose of leather finishing is to protect the end product by improved waterproofing, feel and appearance.

One of the reasons that leather is so popular is that in addition to its great natural richness, it also takes well to a large variety of finishes. There is literally something for every person's taste

The finish acts as a barrier between you and the actual skin .It helps prevent staining and keeps the leather color consistent over may years. Finished leather is the most widely used leather in the industry. Its features color consistency, durability and case in cleaning. Following are some finishes commonly used.

1. **Pigmented Top-Coated (Includes Antique Finishes)**

   These leathers have several spray coats of a pigmented (paint like) finish giving a depth to the colour, plus a clear coat for extra protection. Regarded as the most practical of upholstery leathers. Recommended for wear areas of heavy or hard wear i.e. hotels, offices, family rooms, car upholstery, etc. These leathers soften with use and have good resistance to fade or colour loss.

2. **Aniline**

   Aniline leather is the most natural looking leather with the unique surface characteristics of the hide remaining visible. To get such aniline leather you need to apply what’s called “ aniline finish “ Leather with an aniline finish is colored with dyestuffs only which means no opaque finish ie transparent finish so that the original grain surface can be seen through. Another transparent top coat can be applied to give bright finish and water repellent surface . Aniline finished leather has excellent tooling , polishing , and re-dyeing properties

3. **Semi-Aniline**

   These leathers are colored by dye only. Then a coat of a clear sealer is applied as a protective coating. The prefix semi is used to advise that a protective surface coating has been applied. These leathers are suited to medium to light wear areas. Very soft, they often show the natural markings of the hide, healed scars, growth marks, etc. Do not place in direct sunlight, as resistance to colour loss is medium.

4. **Waxed or Oil**

   After dyeing these leathers are finished with wax or oil or a combination of both. These special waxes and oils provide a protective coating plus enhance the base dye colour. For areas of heavy to medium wear, ie family rooms, dens, etc. This leather may lighten in colour over time requiring replenishment of the waxes and oils (refer section Waxed Oiled Leather back page). Do not place in direct sunlight, as resistance to colour loss is medium.

5. **Nubuck**

   A nubuck is an aniline (dyed only) leather, lightly snuffed or sanded leaving a nap or velour type finish. These leathers are coloured by dye, however, they can be air brushed very lightly with pigment to give added colour. They do not have any protective surface coating. However, they have some protection through the addition of special treatments during the processing. This will give some resistance to soiling or spillages. Do not place in direct sunlight, as resistance to colour loss is medium to light. Recommended for wear areas of light soiling.

6. **Suede**

   Suede has a soft, luxurious touch and appearance. When bushed by hand there is visible patterning called nap and the fiber brushed in one direction. Suede generally has very little protection from dirt or staining and required specialist care. Regular cleaners and conditioners are not suitable for maintaining suede.

Leather Defects

Leather is an incredibly wonderful natural fabric that's been used for thousands of years**.** Structure of a hide or skin resulting in unsightly appearance and/ or weakness of the resultant leather. Such defects may have arisen during the life of the animal, or may have developed in the flaying and/or preparation of the stock. Defects exist on natural leather surfaces and they usually cannot be eliminated during processing. No international criterion specifies the compensatory counting for calf leather surface defects. So complicated negotiation causes additional cost and argument between suppliers and purchasers.

Defects Caused to Hide (During the Life of Animal)

1. **Scratches**

   Scratch is caused by barbed wire, goads, sharp projections and the horns of other animals. Irritation caused by ectoparasites increases scratch damage due to rubbing and wounds can then become infected

2. **Scars**

   Scars, resulting from scratches or cuts. (When the cut is healing, the fibers grow densely packed together, and the healed skin is often hard, raised, and lacking hair follicles

3. **Dung**

   Dung accumulates on cattle. Prolonged contact with dung leads to severe irritation of the skin and can lead to infections. Factors affecting dung build up include weather, housing and holding conditions and farming system.

4. **Infestations, Such as Ticks, Warble Flies, and Mange**.

   Ticks pierce the skin to suck blood, leaving holes that look either like pin pricks or minor scars in the grain of the leather. This defect occurs mainly in the belly areas of the skin. Sarcoptic mange mites enter the epidermis and tunnel around, causing the cells to multiply and the hair to fall out. The grain surface becomes roughened, and the animal generally compounds the damage by rubbing to relieve the itching. In demodectic, or follicular, mange, the mites penetrate into the dermis itself, where a wall of fibers is formed to surround and "encyst" them.

5. **The Cysts**

   The cysts generally are seen on the grain of unhaired skins as small swollen nodules. Tanning and drying processes shrink the contents of the cysts, causing the grain surface to sink over the cavity so that the defects are seen as shallow depressions, though the grain surface itself is not generally damaged

6. **Ringworm**

   Ringworm, which is a fungus, heals it leaves no scars, but if the animal is slaughtered while still infected, the grain appears coarse at the site of the infection

7. **Cockle**

   Cockle, which occurs in woolen sheep immediately before shearing. This defect appears as boil-like hard spots, of varying size, which occur in rows at right angles to the spine from the shoulder to the butt, and, while the defect disappears rapidly after shearing, it cannot be eliminated during manufacture of the leather

Defects Caused After the Death of an Animal

1. Flay Cut

Flay cuts and gouges, which cut into the fibers of the dermis. (In thin leathers they show through and thereby spoil the grain. Some flay cuts go completely through the hide or skin, ruining it completely. These kinds of cuts are usually the result of careless or improper flaying.

2. Putrefaction

Putrefaction, which is the result of bacterial growth, which starts almost immediately once the animal, is dead, unless the skin is properly cured, especially on the exposed flesh side.

3. Vainness

Vainness, in which branching lines of blood vessels can be seen on the flesh side. If, because of poor curing or old age, for example, the structure around them becomes loose, the skin is said to be veiny, and the branching pattern of the veins usually shows through on the grain side. Veininess can actually at times be attractive in some skins, such as VELLUM.

4. Damage from heat

Damage from heat, which may occur on hides and skins in tropical areas. It is a common fault with ground-dried skins. Sun Damage that occurs to a hide or skin when it becomes heated above a certain critical temperature while it is still moist and is laid out in the sun to dry (cure). A completely dry skin can become very hot and still not be affected under normal conditions of cure, but prior to this a skin is very susceptible to damage.

Chapter - 4

Footwear

Form the middle of the 19^{th} century, out sole of footwear has been changed in materials. Leather has been the traditional soling material, after 1980 only about 5% of shoes have leather soles. These days, most of the soles are made of rubber or plastics, which are classed as synthetics. So new types of soling needs new adhesion method or technique with different types of upper materials also they are different in bonding strength. The Polyurethane is one of them that become a most popular soling.

In English, the term “shoe” dates back to many centuries beginning with the Anglo – Saxon. “Sceo” means a foot covering and evolving into “Schewis”, then “Schooys” and finally “shoe”. The German “Schuh” has the name origin. Through the centuries the word “shoe” has evolved with at least 17 different spelling and some 36 variations of the plural. Any foot covering in tae form of shoes, boots, slippers or hose used for utility and dress wear.

Any form of footwear made of various kinds of materials or combination of materials like leather, canvas, rubber, textiles, wood and synthetics to protect the foot from cold, heat, thorns, hazards etc. and to serve as a costume in the form of sandal, shoe or boot. These shall include walking shoes, dress shoes, occasional footwear, sports footwear, occupational footwear, orthopedic and surgical footwear meant for the use of babies, children, ladies or gents.

Purpose of Footwear

The shoe has two primary functions to perform and has acquired through the years other lesser ones. The primary functions are:

1. **To protect the sole of the foot**

   To protect the sole of the foot from the heat, cold, dampness, dirt or roughness of the ground in walking and standing. In its simplest form this is achieved in the primitive “sandal” which is nothing more less than a piece of leather, wood or other material, fixed under the foot by a strap or other means.

2. **To protect the top surface of the foot**

   The upper part of tae foot, and if required, the lag, from cold, rain, thorns, heat and insect or other bites. In its simplest form this is a bag of leather or material wrapped round the foot and is hare given the generic name of “Moccasin”. It is essentially that worn by a hunter, as it is flexible and specially suited to forest conditions.

3. **To assist the foot to perform some abnormal task**

   This includes the various sports such as football, cricket, hockey, running, fishing, riding, mountaineering, dancing, etc. all of which today have their own special footwear. So, also, have many trades, such as mining, deep-sea diving, munitions manufacture and fire-fighting, and the armed services. It should be noted here that more primitive peoples with much stronger and tougher feet can tackle many of these sports, pastimes or occupations without special shoes, or, in fact, without shoes of any kind.

4. **To complete a costume**

   This is particularly important today when costume designing includes not only the dress but also the hat, shoes. Gloves and handbag. In fact, the main purpose of the shoe may be to complete or enhance the remainder of the costume, the primary functions of foot-covering and sole-protection being subordinate to this.

5. **To overcome abnormalities**

   In the foot itself, the surgical boot being the extreme example of this, while many shoes incorporate corrective devices, some more corrective in name than in fact.

Parts of Footwear

There are four internal components of shoe: upper, insert mid sole, and sole

1. **The Upper**

   The upper is the body of the shoe that holds the mid sole and sole in place. The design is different fo each different type of shoe due to the function and style of the shoe. For of the upper in an athletic shoe and dramatically different from a sandal. even though the style of uppers varies, each upper has the same function to provide support and stability to the foot in the shoe.

   a. **Vamp**

      The vamp covers the dorsum of the foot (includes the tongue piece) and superior aspects over the toes. This section i.e. the toe puff is reinforced which serves to give the shoe its shape as well as protect the toes.

   b. **Quarter**

      The complete upper part of the shoe behind the vamp line covering the sides and back art. The top edge of the sides and back of the quarter describes the top line of the shoe. In athletic shoes the top line is often padded and referred to as a collar. The medial and lateral sections join in a seam at the posterior end of the shoe.

   c. **Toecap**

      Many shoes incorporate a toecap into the upper of the shoe. Toecaps are either stitched over or completely replace the distal superior aspect of the vamp and can be made into a decorative features referred to as toe tips. The toe box refers to the roofed area over and around the part of the shoe that covers the toes.

      Linings

   d. In quality shoes the quarters and vamps are lined to enhance comfort and durability. Linings may consist of various materials i.e. leathers, fabrics, and manmade synthetics.

      Throat

   e. The central part of the vamp is just proximal to the toe box. The throat is formed by the seam joining the vamp to the quarter i.e. throat line. The position of the throat line depends on the construction of the shoe, for example a shorter vamp and longer quarters define a lower throat line.

   f. **The Tongue**

      The tongue of a shoe is a strip that runs up the top-center of the shoe and sits on the top part of the foot. Nearly always found on shoes with laces, the purpose of a shoe tongue is to protect the top of the foot, and to keep the laces from rubbing the foot. Definition: The top lift is the bottom-most part of a shoe's heel, the part that comes in contact with the ground. In women's stiletto heels, the top lift is often a separate piece that can accidentally be detached. Fortunately, a shoe repair shop can usually replace top lifts.

g. The Eyelet

The eyelet is the smooth circular piece that laces are thread through. Eyelets can be made of metal or plastic, and are used to cover the edges of holes made in shoes or clothing.

An eyelet provides a smooth, rigid surface for laces to be fed through, and stops the fabric from fraying where the hole was made.

g. Shoelaces

Shoelaces are laced through the eyelets of a shoe, and are used to bring the sides of the shoe together. Often called "shoe laces" or simply "laces," shoelaces give the wearer a bit of control over how tightly the shoe will fit around the foot but they shouldn't be left too loose, and they should never be pulled too tightly. Shoelaces can be made from many different materials, and some tout special features like extra strength to prevent breakage, or coiled ends that need no tying. Also Known as laces, shoelaces

2. The Insert

The insert influences the fit of the foot inside of the shoe because of its design to help position the arch of the foot in the shoe. As well as positioning, the inserts roes are to dissipate heat away from the foot, remove excess.

Moisture, and limit odor emanating from the foot. The insert can be modified by including increased cushioning, and by further modification of the position of the foot in the shoe. For work that requires prolonged standing, increased padding can help to increase the shock absorbency of the shoe and help prevent fatigue during long periods of standing.

Some user use orthotics in their shoes. orthotics aid workers with naturally flat feet and treat certain foot problems caused by the incorrect positioning of the foot while standing, walking and running, they hold the foot straight with the leg when the foot is on the found in supporting it in the shoe and also preceding increased cushioning for the foot. An excellent ways to view orthotics is that they do for the feet and legs what glasses do for the eyes.

3. The Mid sole

The mid sole is located between the sole of the shoe and the upper. This region of the shoe supplies much of the cushioning and shock absorbing capabilities of the shoe. Mid sole accomplishes cushioning and shock absorption are accomplished by mid soles having areas of pressurized air, liquid, or gel systems. Recent advances in mid sole design have increased the cushioning capability by advances in the types of gas, liquid and gel used for cushioning, types of molds used for the mid sole, and types of materials used for the both the mid sole and the cushioning system of the shoe.

Stability of the foot is not only accomplished by the upper of the shoe but also the mid sole while the upper focuses on stability of the heel, the mid sole provides stability for the ankle and increased stability for the foot as a whole. As with the upper, the more stiff the mid sole, the more stability it will provide the foot in the shoe.

4. **The Sole or Out sole**

   For a slip, trip and fall perspective shoes have different tread patterns for reasons of function and aesthetics, for example, the tread pattern of a soccer boot is much different from that of a dress shoe. However, even though these treads are dramatically different from each other, they fulfill the traction requirement s of the activities for which thy are used. The traction properties of a shoe are typically measured by the COF between the sole of the shoe and surface on which the shoe is being used, slop resistant soling will be discussed later in this paper.

5. **The Foot Bed**

   The foot bed is the inside part of the shoe that runs under the bottom of the foot.

6. **The Heel**

   The heel is the outer part of the shoe that is placed under the heel of the foot. Shoe heels come in a wide variety of styles, shapes and heights. In fact, even shoes that are referred to as "flats," will often have a heel. Also Known As: insole, inner sole, innersole.

7. **The Heel Breast**

   Is the side of the heel that faces forward when the shoe is on the foot? In women's high-heeled dress shoes, the heel breast will occasionally be a different color than the rest of the heel.

8. **Covers**

   In some cases, shoe covers can be used to protect the wearer's shoes, as is the case with medical professionals who often wear disposable shoe covers to protect their shoes from blood, while also preventing footwear germs and debris from entering a sterile environment. Other times, disposable shoe covers are worn to protect flooring from debris that might be on the wearer's original shoes. For example, realtors and home service workers often wear shoe covers when entering a client's home, so as to protect the homeowner's carpets or floor from dirt and mud. More durable footwear protection can be found in the form of overshoes. Also Known As: shoe covers, disposable shoe covers, overshoes, disposable overshoes, shoe protectors, galoshes, disposable galoshes

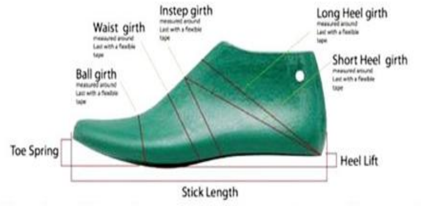
9. **Spats**

   Spats are fabric accessories that are worn over shoes. They cover the shoe throats and are usually long enough to cover the wearer's ankles. A spat generally has a strap that wraps beneath the shoe, and is placed between the heel and the ball of the foot. Spats can be worn inside of pants, or with pants tucked into them. Spats have often been used decoratively as a part of traditional and military uniforms, and marching bands often utilize them as well. Some spats are designed as protective accessories; for example, welders might wear leather safety spats to prevent burns.

Shoe Lasts

The word “last” comes from the Old English “laest,” meaning footprint. However, a finished last is by no means a carbon copy of your foot. It’s something of an abstraction, based on up to thirty-five measurements which are then tailored to the design and intended function of the shoe. Lasts can differ amongst shoe styles of a single brand or manufacturer.

Shoe lasts are foot-shaped forms used by shoemakers to shape shoes as they're being made.Shoe lasts are usually made from wood or plastic,


Instep girth
measured around Last with a flexible tape
Waist girth
measured around Last with a flexible tape
Long Heel girth
measured around Last with a flexible tape
Short Heel girth
measured around Last with a flexible tape
Ball girth
measured around Last with a flexible tape
Toe Spring
Heel Lift
Stick Length

Types of Footwear

1. **Dress and Casual**

   Smooth and supple leather uppers, leather soles, and narrow sleek figure characterize dress shoes. Sturdy leather uppers, non-leather outsoles, and wide profile characterize casual shoes. The majority of dress shoes have an upper covering, commonly made of leather, enclosing most of the lower foot, but not covering the ankles. This upper part of the shoe is often made without apertures or openings, but may also be made with openings or even itself consist of a series of straps. Shoes with uppers made high to cover the ankles usually considered a boot but certain styles may be referred to as high-topped shoes or high-tops. Usually, laces or zippers secure a high-topped shoe, although some styles have elastic inserts to ease slipping the shoe on.

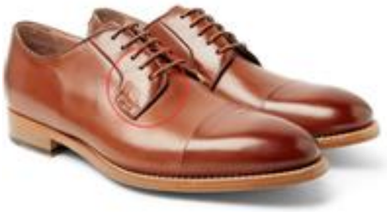
2. **Men's**

   This male dress shoe, known as a blucher, is distinguished by its open lacing. Men's shoes can be categorized by how they are closed:
3. **Oxford**

   An Oxford is a lace up shoe that has the bottom of the lacing section sewn closed and one that also has the eyelet facings stitched underneath the vamp (front section of the shoe). This style of shoe is also sometimes referred to as a closed front shoe due to the fact the lacing section is is sewn closed.

4. **Derby**

   A Derby shoe is also a lace-up shoe but one which has an open lacing section (is not sewn closed at the bottom). The eyelet facings are also sewn on the top of the vamp. Derby shoes are also often referred to as a Gibson shoe.

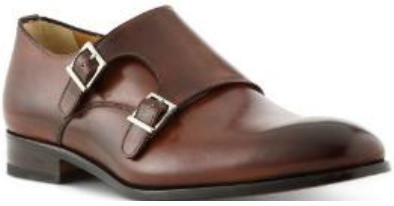


5. **Bluchers (American), Derby (British)**

   The laces are tied to two pieces of leather independently attached to the vamp; also known as "open lacing".

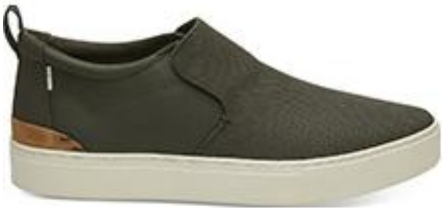
6. **Monk-Straps**

   A buckle and strap instead of lacing



7. **Slip-Ons**

   There are no lacings or fastenings. The popular loafers are part of this category, as well as less popular styles, such as elastic-sided shoes.

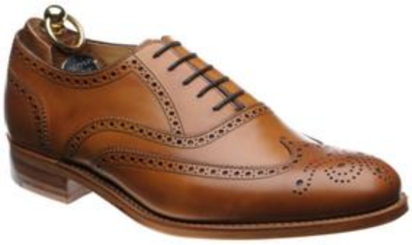


8. **Cap-Toes**

   Has an extra layer of leather that "caps" the toe. This is possibly the most popular decoration.

9. **Brogues (American: wing-tips)**

   The toe of the shoe is covered with a perforated panel, the wing-tip, which extends down either side of the shoe. Brogues can be found in both balmoral and blucher styles.



10. **Women's**

    There is a large variety of shoes available for women, in addition to most of the men's styles being more accepted as unisex.

11. **High-Heeled Footwear**

    Footwear that raises the heels, typically 2 inches (5 cm) or more above the toes, commonly worn by women for formal occasions or social outings.

12. **Sneaker Boot**

    A shoe that looks like an athletic shoe, but is equipped with a heel, making it a kind of novelty dress shoe.

13. **Mules**

    Mules are shoes or slippers with no fitting around the heel (i.e. they are backless)

14. **Sling Backs**

    Sling backs are shoes, which are secured by a strap behind the heel, rather than over the top of the foot.

15. **Court Shoes**

    Court shoes known in the US as pumps, are typically high-heeled, slip-on dress shoes.

16. **Sandals**

Open shoes consisting of a sole and various straps, leaving much of the foot exposed to air. They are thus popular for warm-weather wear.

17. **Slippers**: For indoor use, commonly worn with pajamas.

18. **Orthopedic**

The word 'orthopedic'. 'Ortho" is a Greek word (root) that means 'correct' or 'right' and 'pedic' means 'foot'. Together the word means 'correct feet'. Orthopedic shoes are worn by people of all ages who suffer from poor foot mechanics as they are specifically designed to support the structure and mechanics of the foot, ankle and leg.

There are certain characteristics, or design features, of orthopedic shoes which sets them apart from regular shoes, such as padded removable foot beds, wide toe boxes and arch support are made especially for those with problematic feet.

19. **Work Shoes**

Work shoes are designed to stand heavy wear, to protect the wearer, and provide high traction. They are generally made from sturdy leather uppers and non-leather outsoles.

Manufacturing Process of Footwear

Shoemaking is a labor-intensive process, and the cost of producing the many components of the running shoe reflects the skilled labor necessary. Each phase of production requires precision and skills, and taking shortcuts to reduce costs can result in an inferior shoe.

Raw Materials

Shoes are made from a combination of materials. The sole has three layers: insole, midsole, and outsole. The insole is a thin layer of man-made ethylene vinyl acetate (EVA). The components of the midsole, which provides the bulk of the cushioning, will vary among manufacturers. Generally it consists of polyurethane .Outsoles are usually made of carbon rubber, which is hard, or blown rubber, a softer type, although manufacturers use an assortment of materials to produce different textures on the outsole.

There may be a leather overlay or nylon overlay with leather attachments. Cloth is usually limited to the laces fitted through plastic eyelets, and nails have given way to an adhesive known as cement lasting that bonds the various components together.

Design

Over a period of time witnessed great changes in the design of the Boots /shoe, which now comes in all styles and colors. Contemporary designers focus on the anatomy and the movement of the foot and analyze such factors as limb movement, the effect of different terrains on impact, and foot position on impact along with pressure points, friction patterns, and force of impact, this information is fed into computers which calculate how best to accommodate these conditions. Designers next test and develop prototypes based on their studies.

Boots /shoe may have many parts to it and the components are the most basic, has two main parts: the upper, which covers the top and sides of the foot, and the bottom part, which makes contact with the surface. The bottom has three main parts, outsole, midsole, and liner.

1. **Boots**

   Footwear that covers the whole foot and lower leg.

2. **Shoes**

   Footwear shaped to fit the foot (below the ankle)

Steps of manufacturing of Boot / shoes

Step 1: **Cutting the pattern**

Almost every pair of shoes we make at Shoes is unique and so requires a unique pattern to be cut. Pattern cutting involves creating the shape of each component of the shoe. With all our possible shoe combinations and each shoe size requiring a new pattern, An upper is the part of the shoe that sits on top of the foot. The other parts of the shoe that need to have patterns made include; the sole (the core of the bottom of the shoe); the insole (the internal part of the shoe that sits directly under the foot); the outsole (the outer layer that directly touches the ground) and the heel.

Step 2: **Tools of the Trade**

One of the most important tools for making a shoe is the last, something which customers never normally get to see! The last is a foot shaped piece of material over which the shoes are molded. A different last is used for each shoe size and style. For example, a shoe with a pointy toe will be molded using a last with a pointy toe. The last is so important because it determines the fit and feel of the shoes.

Step 3: **Edging**

Edging is the process of flattening the edge of the pieces of leather that have been cut to the pattern so it is thinner than the rest of the leather piece. This makes for crisp, neat joins between pieces of leather giving you a much more comfortable fit as well as the quality finish you would expect from a pair of hand crafted shoes.

Step 4: **Stitching**

The different parts of the shoe are then carefully stitched together.

Step 5: **Trimming preparation**

The next step is to prepare the trimming before it is added to the shoes.

Step 6: **Selecting the Heel**

What size heel would you like? Our stiletto heels come in different shapes and sizes, and you get to pick! These become the core of the heel of your shoe - encased in the leather you have chosen.

Step 7: **Trimming the Excess**

This involves carefully putting together and making the finishing touches to the decorative upper for another pair of handmade shoes.

Step 8: **Preparing the Sole**

The core pieces of the sole of the shoe are then covered either side by the insole (the piece that sits against your foot) and the outer sole (the piece that sits against the ground).

Step 9: **Affixing the Outer Sole**

The outer sole is the affixed to the shoe.

Step 11: **Finishing**

The final cutting, cleaning and polishing of the shoes. The shoes are then boxed and shipped straight to your waiting feet Trade

Quality Control

Manufacturers can test their materials using procedures developed by the Shoe and Allied Trades Research Association (SATRA), which provides devices designed to test each element of the boot./ shoe. Once the shoe is complete, an inspector at the factory checks for defects such as poor lasting, incomplete cement bonding, and stitching errors. .

Soling Manufacturing Process

The sole is a critical component of any item of footwear. It protects the foot from the ground, and contributes substantially to the structural integrity of the shoe. The user must ensure that footwear chosen protects against the risks involved in the work place, than the styles and materials are compatible with the working conditions in terms of both withstanding the effects and protecting the wearer against them.

The performance of footwear depends on the overall design and construction, i.e. the upper, lining, insole, midsole and outsole all contribute. *The* sole of a boot or shoe is important because it is in direct contact with the ground. It should help to:

1. Provide the wearer with a stable base.
2. Reduce risk of injury through shock when running, jumping etc.

3. Provide traction and reduce risk of injury through slipping.
4. Give insulation from sharp projections on the ground,
5. Give heat insulation.
6. Provide an acceptable wear life under specified conditions.

The relative importance of these factors depends on the purpose of the footwear. Even the design of a sports shoe sole will depend on the type of sport. Rock climbing, fell walking, skilling, jogging, squash, football etc. all involve different types of movement on different types of ground surface.

In spite of the diversity of applications, it is possible to give some general design guidelines. The following applies mainly to molded sole units, but is also applicable to direct molded soles and to sheet soling.

Soling Thickness:

The thickness of a sole must be sufficient to provide an acceptable level of ground insulation, and an acceptable wear life. A minimum of 2mm in' any type of sole is needed to give a stable base for the tread.

Types of Soling Materials

There are different types of soling, materials. They are:

1. Leather / Leather board
2. Rubber
3. Thermoplastic Rubber /PU
4. PVC
5. EVA

Natural Rubber

Natural rubber was one of the first materials to be used in shoe soling application. Vulcanization of the Rubber was discovered by Goodyear in 183940, followed and developed by Dunlop.

Vulcanized rubber is still used in casual & canvas shoes. Recently TPNR Thermoplastic natural rubber was developed in Malaysia to avoid vulcanization process associated with Natural Rubber. TPNR is manufactured by blending of dynamically cross linked NR with PP. But commercially it did not succeed as it could not produce softer soling material below hardness of 70 shores, and also escalating natural rubber prices made it unattractive.

Synthetic Rubber:

It was developed after researching on different synthetic materials and oils in 1920. By the end of World-11 in 1945 SBR rubber was finally taken-up as a substitute for natural rubber.

Thermoplastics

1. **PVC- Polyvinyl**

   PVC- Polyvinyl chloride is a wonderful material which can be compounded to produce soles in various harnesses and can be compact or microcellular. But its higher weight maker it least preferred choice in high value high performance shoes. With the advent of SUPER- EXPENDED PVC presents a poor resistance or abrasion and hence it is used only for seasonal articles such as beach sandals and slippers. The soles are produced on air blown machines using a foamed PVC compound.

2. **TPR- Thermoplastic rubber**

   TPR**,** Thermoplastic rubber is manufactured from oil bound S. tyrene-butadine-Styrene block copolymer. Similar to PVC this material can also be super expended to produce light weight soles. This material can also reach a specific weight of 0.5 but has a fairly good resistance to abrasion and other characteristics appreciated by the sole market. Moreover, it lends itself very well to the two-material using a semi-compact TR for the outsole and a super expanded TR as midsole.

3. **EVA-** Traditional System of Sheet Vulcanization.

Adhesives

Adhesive is a sticky substance used to bond two more pieces of material. In the shoe trade it also known as cements and used to bond the outsole or linings to the upper. To sole bonding system it plays a vital role. There are some characteristics that influence its property.

Type of Soiling Manufacturing Process

Common sole manufacturing processes are as

1. Direct Injection Molding
2. Pouring
3. Sticking on
4. Direct Molding

   a. **Direct Injection Process (DIP) PU**

      The PU, in liquid form is Injected into the closed mold (holding the upper) at high pressure. Thus we get the term “Direct Injection Moulding”

      The **PU** hardens and permanently fuses into one piece with the upper. There is absolutely no chance of separation.

      Direct injection moulding or Direct Moulding points to the fact, that the soles are moulded directly onto the upper without use of adhesives or stitching.

      This is possible because of the dramatic speed at which monomers polymerise to form network polyurethane, a process that is so rapid, that articles may be fabricated by injecting the reacting monomers directly into a mould.

      High Mixing speed of over 18000 RPM resulting in better grain structure and thus better physical properties.

"PU Direct Injection Process Moulding (DIP-PU) Machine"

b **PU Pouring Technology**

As the name suggest this technology uses the method of pouring the liquid mixture into an open mould.

"PU Pouring Head"

The basic principle involved in this technology is the mixing of two liquid chemicals, Polyol and Isocyanate, using a mixing head and pouring the liquid mixture at low pressure into an Open Type Aluminum Mould, thereby PU remains in open condition for sometime.

With P.U. pouring technology, there are two options:

1. The mixing head is stationary, and the mould-holders move these machines normally have 32, 40, 60, 90 or 100 stations, as per production required, and are costly options.
2. In the other type, called the mixer is moved manually, while the mould-holders/ moulds remain stationary; in such a case you could have 6, 12, 18, 24 and up to 32 stations / moulds and is a more economic option.

Army Footwear

History

Boot was used in Pak Army as per British mil specifications till 1964. Pakistan mil specifications were prep without changing the tech parameters of British specifications in 1964. The main features of the boot were as under:-

1. Derby with toe fitted with iron head and toe tip
2. Full grain Zuggrain cow leather
3. Leather laces
4. Buffalo vegetable tanned Leather
5. Linen stitching thread

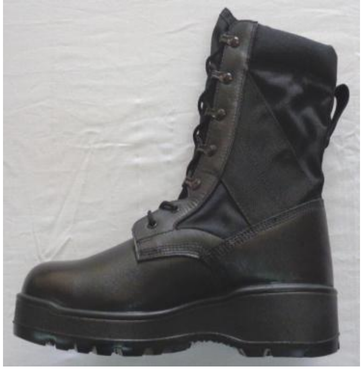
In the year 1977, Boot Dir Molded Sole (DMS) was dev and introduced in svc in 1977. Minor modification were made time to time to improve serviceability and durability.

1. To protect the boot from damaged and wrinkles 'V' cut after 5th eyelet from top was made.
2. For more comfort and easy / speedy lacing, Full bellowed tongue with 1" curve from top.

In 2014 following boots/Shoe were develop and later on inducted in to SVC

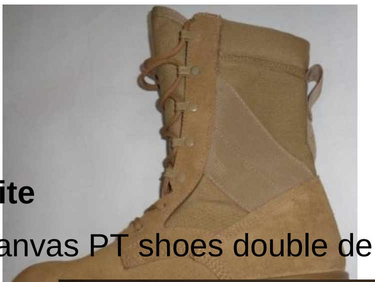
1. **Combat Boot Black with Cordura Cloth**

   Initially inducted in full leather later on Cbt Boot Black with Cordura inducted in to service replacement of Boot DMS.



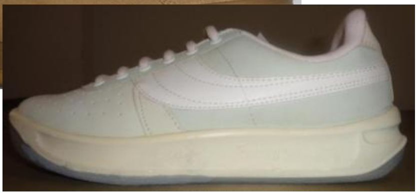
2. **Combat Boot Suede**

   With induction of new CCD uniform and latest trend in the contemporary Army new boot was introduced and inducted in service



3. **Shoe Jogger White**

   Replacement of canvas PT shoes double density sole shoe was introduced



Chapter - 5

Care for Leather products

Leather Boots Cleaning

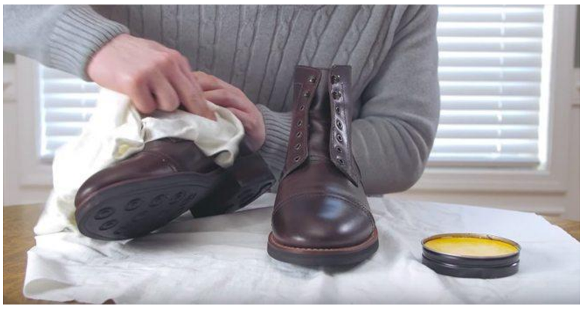
Boots like other shoes serve as the base of your outfit. They're subject to the most abuse among all clothing items. They constantly strike the ground making contact with dirt, snow, salt, grime, and greasy substances. So there's no denying how important it is to clean them regularly.

Materials for Cleaning

1. Piece of old cloth
2. Horsehair/Hair brush
3. Slightly damp rag
4. Saddle soap

The first step is to remove the laces that make it easier to clean and condition the boots. Then wash the laces in soapy water to get rid of dirt and grime or get new ones if you notice they're old or worn out.

Place the boots on an old piece of cloth that's flattened on a table. Use a horsehair brush to give the leather some light buffing. The goal here is removing any loose dirt or salt particles which can damage the leather eventually. Ideally, you should give your boots a quick brush after each time you wear them outside. But a minimum of once a week is enough.



Get the damp rag and rub it over your saddle soap to create a light lather. Then rub the lather over the boots, especially over areas that need extra scrubbing. But take note you don't have to do this every time you clean only for those really stubborn stains. Let the boots air dry for 10 minutes. Then expect them to look good as new afterward.

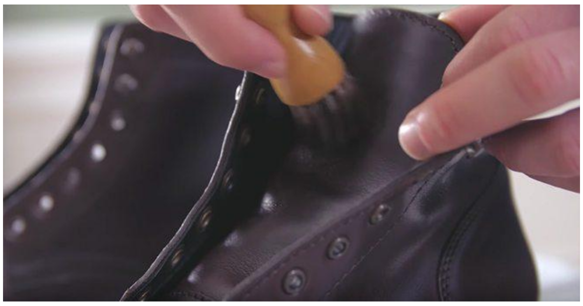
Conditioning

Dirt isn't actually the biggest problem for your leather boots. When the boots are affected by water damage (as in natural moisture escapes the leather) they dry out. The fibrous interweave will start to weaken and visible cracks form. Sadly, there's no way to salvage them once that happens.

So prevention is key. By always keeping the leather supple, healthy and resistant to water penetration that means you should also condition leather shoes/boots the day you buy them. Don't expect them to come out of the box well-conditioned. The leather could've been left inside a storage room – deprived of oil and moisture for months.

Materials for Conditioning

1. Piece of old cloth (to lay the boots over)
2. Good leather conditioner or balm
3. Small applicator brush
4. 2 dry clean rags



Start by giving the boots a quick rub-down with one dry rag. This is to take off any remaining dirt or particles clinging to the leather. Then grab your applicator brush. Use it to apply your leather conditioner/balm to a small spot testing to see that it doesn't drastically affect the color of the leather. Note that this substance can darken the leather very slightly (especially for the first few days).

So if you have a light colored boot or an exotic leather material, do a spot-test somewhere hidden like along the tongue area. Try waiting a couple of hours before checking the result. If the darkening isn't too bad this is a product that'll work fine.

Now pour the conditioner/balm onto the second rag (best if it's made of chamois or terrycloth) and rub it on the leather. Use circular motions without pushing down hard going back and forth along each boot. You want to get the product in all crevices and creases.

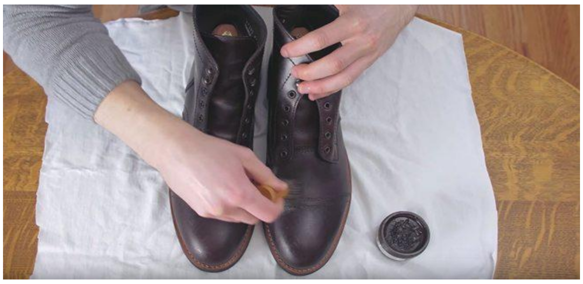
Use as much product as the leather needs. If your boots seem dried out and you haven't treated them in a while do 2-3 applications. Boots in great shape will need just a quick rub all over. Observe when the product stops soaking in and the leather starts to get damp.Wipe off any excess product and let boots dry for 20 minutes. Once they've rested for about 12 hours, give them a rub with another dry rag to absorb any excess oils and moisture.

Conditioning should be done quite often. I'd suggest once every 3 months if you live in a temperate climate and once a month if you wear the boots every day or live in a dry, hot climate.

Polishing/Shining

Polishing your boots (after conditioning) isn't necessary. But it gives your leather boots more smoothness overall. While you don't have to consider polishing rugged boots you'd probably like some more shine.

1. Materials for Polishing
    a. Piece of old cloth (to lay the boots over)
    b. Either a shoe cream polish or wax-based polish
    c. Small applicator brush
    d. Soft clean rag
    e. Clean horsehair brush (NOT the one you used for removing dirt)



2. Steps to applying cream polish
    a. Check that you've got a cream with a color that matches the leather.
    b. Use the applicator brush to work the cream evenly over the entire boot, and the same for the other boot. Start off with a small amount then add more if needed.
    c. End with a quick buffing using the horsehair brush.
    d. Dry the boots for 15 minutes.
    e. Cream polish doesn't provide as much shine as wax-based polish but adds extra moisture and nourishment. It'll also help bring back the natural color of your boots when the leather starts to fade.

3. Steps to applying wax-based polish
    a. Wrap the soft rag around two fingers and dip them into the wax
    b. Apply the polish onto the leather using small, circular motions. Keep working until you coat the entire boot
    c. Leave that leather boot aside and do the same for the other

d. Do a quick buffing using the horsehair brush and repeat this once or twice to get a really nice shine
e. The wax-based polish must be the final layer when you're polishing your boots. Don't attempt to put cream polish over it
f. Wax-based polish adds shine and protects your boots against salt or water. It also tends to lock the leather conditioner in so you can extend the time that passes before re-applying it. It doesn't moisturize the leather but don't be concerned if you've got a reliable conditioner

For polishing, do (if you wear the boots daily) or polish thoroughly once a week (following either of the 2 methods step-by-step).

Waterproofing

In general, leather boots with a good quality are water-resistant. So you just have to be consistent with conditioning your boots before they get wet or exposed to the elements outside. If you insist on taking extra measures to waterproof

a. Use a wax-based polish after conditioning
b. Apply a waterproof spray over the leather but make it's the last thing you put

But what happens if your leather boots get really wet despite the protective substance? First do NOT leave them next to a fire or other type of heat source. High heat can cause the leather to dry too quickly and crack. The best solution is to let your boots air dry at room temperature. That's all there is to it.

Suede Boot Cleaning

Suede is a stylish but delicate clothing material. This means there are multiple techniques for cleaning suede items you can pick. I'm going to break down each one of them. But always check the label of your item for cleaning instructions before you proceed with any method.

1. **Brushing (After Heavy Use)**

   This involves a brass wire brush (for very short suede) or an actual suede brush (the kind with a visibly fuzzy nap). Perform quick, light strokes while using either one so the bristles get deep into the fibers removing dirt/scum or dust.

Do NOT press too much except if you're dealing with stubborn marks. Don't brush on a hard surface, place a towel underneath the shoe. Always brush the nap of the suede in one direction. This keeps the item looking consistently clean and tidy. For suede with a longer nap, it's better to use a multi-headed brush or crepe brush for extra softness. Another option is the double sided brush with a soft-bristled brush on one side and a suede block on the other.

Alternatively, try a suede eraser (or a standard pencil eraser if you don't have) to remove dirt smudges or stains and it's okay to rub harder with it. But for nubuck suede, use a suede block. This will erase any stains plus soften any leathers which have sheen from over wear.

If the nap of your item looks tired and flattened all over, hold it above steam from a kettle (or better yet a steam cleaner) for a few seconds and then proceed to brush.

2. **Dab with Water (For Wet Shoes)**

This is a legitimate way to use water for preventing stains – particularly on a pair of clean wet suede shoes. If you've just now spilled water, apply pressure on them with a paper towel.

If you have the patience to do this until it's dried up most of the moisture…you may avoid a water stain. For shoes that are water-stained but not soaked all over, spray/brush a thin layer of water evenly over the whole upper. Brush the stains gently and work around the edges.

The next step is the same whether your shoes got soaked in the rain or you just covered them with water. Use a sponge or dry cloth to soak up any excess water. Dab gently until the leather is evenly wet. Stick blank white paper (not newspaper) and shoe trees in your shoes to soak up water and help the shoes retain their shape.

Leave the shoes overnight in a dry, well-ventilated area. Once dry (or while they're drying if you prefer) go over the shoes lightly with a suede brush. This helps shake out the grain back to its original look.

Note: Never put a suede item next to a heater or through a dryer. The high heat can cause it to shrink, fade and become warped or as hard as jeans.

3 **Cornstarch / Talcum Powder**

If you've spilled liquid on your suede item, pat the affected spot with a clean cloth and apply a layer of cornstarch or talcum powder. Let it settle overnight. Then use a suede brush to remove the dried powder. Don't be tempted to clean wet stains, you will only make them worse.

Once the stains are dry ,rub over them using either (

a. A suede cleaning block
b. Either an emery board or a low-grit sandpaper but rub carefully. When you've removed the stain, brush and re-spray the item. Then use an eraser to restore the nap.

4. **Cleaning Methods For Specific Types Of Stains**

   a. Mud Stains: Wipe away excess mud without pushing too hard against the suede then leave to dry. Break off the larger chunks with your hands before finishing with a suede brush.
   b. Blood Stains: Dab at the stain with a peroxide-soaked cotton ball slowly until the blood comes out.
   c. Wax/Chewing Gum: Put your item in the freezer for a few hours to harden the gooey substance so you can chip it off. Finish with a suede brush.
   d. Coffee/Tea/Juice: Place two layers of paper towel over the stain before you start using a brush. Apply moderate pressure with your hands or a flat object.
   e. Ink Spills: Quickly grab a paper towel and try to blot the ink up. If it sets, scrape the stain off with sandpaper or try using a rubbing alcohol-soaked cotton ball.
   f. Salt Lines: Apply a small amount of white vinegar through a soft rag or towel. Let it dry and then agitate with a suede brush.
   g. Oily/Unknown Stains: Use a suede brush to scrub the stain as you would for dirt or dust. Then use a nail brush with warm water to scrub off stubborn stains.

5. **Irremovable Stains**

   If all else fails and the stain just isn't coming off:

   a. Take your stained suede shoes to a cobbler
   b. Take your stained suede jacket to a dry cleaner who specializes in leather & suede

   It may not be the cheapest solution but it does guarantee results. You won't risk ruining the suede whatsoever. This would also be a great thing to do BEFORE you stow away your winter suede shoes/boots or jacket during the warm months.

Protection

Here's the reality with suede items. They're mortal bound to wear down and lose their stylishness over time. It helps to know how to de-stain them but they'll never be 100% safe from the elements of rain, snow or salt (unless you keep them in your closet forever). You also can't avoid wearing them in cold weather all the time.

You can take protective measures so you can wear suede even with those elements present (except for days with heavy rain). All you need is a suede protector spray which you'll find in shoe repair stores or drugstores. It's water- and dirt-repellant and the best version would be a waterproof silicone-based spray with a neutral color.

When you've got this spray at home, learn to use it after each time you clean your suede and the item has fully dried. Here's how to apply the spray to your suede items:

1. Check that the suede material is clean and dry (you would've done the appropriate cleaning method first).
2. Test the spray on a small area to see if there's a drastic change in color.
3. If the color is fine – spray the suede-covered areas of the upper and then spray the entire item evenly (some slight darkening overall is natural). Make sure you don't over-saturate.
4. Do one final quick brush in a single direction over the suede.
5. Let the item air-dry on a towel for 24 hours in a well-ventilated area.

How often should you spray your items? I'd recommend spraying suede jackets & belts once every 2 months, and suede shoes once a week (unless you don't wear them for extended periods of time).

Note: Do NOT consider using leather creams or shoe polish. They don't work on suede the way they do on other leather types. They can disrupt the fibers and spoil your suede items even if they aren't stained or dirty.

Storage

There are two main issues to watch out for when storing your suede

a. Direct sunlight
b. A lack of air circulation.

So you ought to keep them in a cool, dry place that doesn't receive sunlight. Suede that's left exposed to the sun can shrink, fade or harden. Avoid wrapping the items in plastic as well. The fibers in the suede need some breathing room.

Another tip is to use shoe trees made of unfinished cedar wood for your suede shoes/boots. Choose the kind with a split toe and fully shaped heel for a close fit. They're meant to quickly deodorize and absorb moisture. But remember to take the suede off the trees within 1-2 hours so as to maintain their foot shape.If you don't plan to wear your suede footwear for quite some time, you can either.

1. Store them in a dust bag.
2. Wrap them in tissue paper and then store in a shoebox.

Care and Maintenance of Leather Garment

Routine Care

1. **For Smooth Leather**

   Use a soft, water dampened sponge or cloth to remove surface dirt or stains.

2. **For Suede or Nubuck Leather**

   Brush regularly to keep dust and dirt from settling in the nap and to maintain its velvety look. Use a brush or block designed for suede and nubuck made for this job. Wear a scarf to protect the collar area from perspiration and body oil. Avoid spraying perfume or hair spray while wearing leather or suede. Never apply tape or adhesive stickers of leather, as the glue will permanently damage the skin.

Storage

One of the many benefits of leather is that it doesn’t easily wrinkle, if stored properly. Leather is a great choice for extended wear for travel. Suggestions to keep your garment wrinkle free

Store garment on a board hang ,not wire, to maintain its shape.

Some garments have a chain loop at the collar do not use this as a hanger. Never store in plastic because leather is skin, which need to breathe. Store leather in cool, dry place leather can mildew if stored in a hot, humid environment. Do not store leather near a direct source of light if wrinkles occur due to improper storage, simply hang garment and brush nap.

If the garments gets wet remove all items from pocket hang on a sturdy, padded hanger, and let air dry naturally away from heat, when dry, brush suede and nubuck items to lift the nap, If stains occurs, blot the area with a cloth dampened with water, if the stains oil based you may sprinkle the area with baby powder or chalk shavings to try and absorb the excess oils. Do not rub the garment sit overnight. Shake powder off and gently brush nap with a suede brush.

Chapter - 6

Leather Testing

Properties of leather to tested are basically of three categories.

1. The strength and wear properties required for the specific use as footwear, upholstery, garment or leather good material.
2. The properties which indicate the quality of raw material used and the standard processing employed in making
3. Leather chemical nature should not be harmful to the consumer in prohibited chemicals. These tests are just to confirm that they are not present.

Strength

To test the strength of a piece of leather, fold the leather as a single fold perpendicular to one of the edges and cut the folded edge with a knife, when you open the fold you have created a loop parallel to the edge. Put your index finger in the hole and pull the loop and try to tear the piece off. you can feel the resistance of the leather fibers to tearing. If it tears off like appear, the strength is low. If you are not able to pull it off, it is quite strong.

Once you try this test on a few samples you will get a feel of the typical pressures required by different types of leathers perfect it by practicing it often. There are special equipments to measure the strength and tear strength .The specification are different for leather meant for different end user.

Flexing

Leather fibers are subjected to flexing during use. leather may be exposed to light, heat, water ,sweat and acidic /alkaline media during use. The leather surface may be abraded and rubbed. wear tests measure the ability of leather to resist changes due to these factors.

Fastness to Color

The fastness of the surface color can be tested by rubbing with a white cloth held around the index finger, by trial and error you can choose the pressure and number of strokes of rubbing, after rubbing by looking at the color change of the rubbed leather surface and the cloth surface we can judge the rub fastness of the leather surface. By wetting the cloth with water, sweat or any other solution we want to test, we can determine the rub fastness of against the solution. The official tests work on the same principles using more accurate equipment and standard scales for comparison of color change, the tests are dry rub fastness wet rub fastness and fastness to perspiration.

Light Fastness

Light fastness is determined by measuring the change in color of the surface on intensive exposure to a specified light for fixed time duration The other way to determine these property is by cutting a sample of leather in to two pieces and leaving one piece exposed to sun light and keeping the other piece in the dark for a number of days, we can compare the color of each and judge the change.

Spot Test

By placing spots of water, oil or any other solvent on the leather surface and observing how thy are absorbed, we can judge the leathers resistance to wetting by these solvents, By making the leather surface into a cup form and can judge the leathers resistance to wetting by these solvents, By making the leather surface into a cup form and holding water to see the time it takes to penetrate to the other side, we can judge the water resistance property of the sample.

Water Vapor Permeability Test

The ability of leather to transfer water vapor is measured by water vapor permeability test. this is an important test for footwear leathers and measure of foot comfort. The type of finish has the greatest influence on this property. If coating heavily finishes the leather, the water vapor permeability will be relatively poor.

Dye Penetration

By cutting a piece of leather and looking at the cross section, we can determine the difference between the surface color and cross section color. If the cross section color is closer to the surface color, it indicates that the leather is dyed accurately and thoroughly.

Softness

Softness of the leather can be judge subjectively, softness gauge can help in providing a value to softness, even thou thickness is measured by thinness gauge, some people are able to tell thickness of leather just by passing their hands over a folded surface.

The Quality of Tannage /Shrinkage

The quality of tannage can be judge by comparing the shape of a leather before and after placing in boiling water for five minutes, The shape can be compared by drawing out the outline before testing. The official methods measure the shrinkage temperature that is the temperature at which the leather fibers start shrinking.

P^H

P^H of the leather is measured by determining the P^H of the extract of leather sample. The crude method is to soak the leather in water for one or two days and measure the P^H of the solution.

Use of Forbade Chemicals

Detecting and measuring formaldehyde, PCP chrome VI and aromatic amines involve sophisticated equipment and my not be possible to be carried out outside specialized laboratories.

Comfort Tests

Personal comfort is a key factor now every user desires out of products the products they buy .At least everyone curses the products which reduces their comfort nowadays no one likes to wear just for look and appeal alone, comfort to wear is a key factor of like for a brand comfort shall be measured as

Sweet Permeability

Sweet is the way a human breathes through his skins ,a man sweats around 6 mg/min per palm to regulate temperature of skin. This sweat should be let out as vapor by the wear for better comfort avoiding moist slippery smelly legs/body. For this the wear should possess permeability property. Permeability is measured in g/sq m/day, its technical terms moisture vapor transmission rate. Leather is highly permeable by nature, however the cheaper processing for up gradation and water proofing reduces moisture vapor permeability .The standard minimum moisture vapor permeability of leather for shoes is 10 mg /sq cm /day.

Perspiration Impact

Humans sweet contains water and the chemicals such as chlorides and the odorants 2-methylpheonal and 4-methlphenol as well as a small amount of urean. These chemicals are capable of stripping some of the leather chemicals used during its processing mainly coloring chemicals namely dyes and the dye solutions. This on stripping soils the inner wear such as socks and causes skiing blemishes for those who are allergic to these kinds of chemicals. Perspiration is tested by soaking the leather in sweet solution with a perspiration strip after 15 hors of standard humid and temperature control ,the strip and leather are taken of the sweat solution. The sweat solution leather and fabric are observed for coloring change and graded in grey scale, normally grey scale.

Thickness

As most leather today is sold in “Ounce” thickness, the approximate equivalent in inch fractions or millimeters can be compared below. As the hide can still vary in thickness from one part of the hide to another, the gauge is usually defined in ranges, for example 3 - 4 ounces, means the skin will be between 3 and 4 ounces throughout the hide.

Leather Thickness Conversion Chart

Ounce	MM	Iron	% Inch	Decimal Inch
1	0.4	0.75	1/64	0.016
2	0.8	1.5	1/32	0.031
3	1.2	2.25	3/64	0.047
4	1.6	3	1/16	0.063
5	2	3.75	5/64	0.078
6	2.4	4.5	3/32	0.094
7	2.8	5.25	7/64	0.109
8	3.2	6	1/8	0.125
9	3.6	6.75	9/64	0.141
10	4	7.5	5/32	0.156
11	4.4	8.25	11/64	0.172
12	4.8	9	3/16	0.188

Seepage Test

This test is suitable for checking water tightness upper components of boot DMS through seams. Test is performed in a water bath, with the help of water soluble dye. A pair of white cotton socks is properly stuffed in the Boot ,it is then placed in colored water bath so that the level of water should be above sole and hell height the boots, Test carried out for 2 minutes, Boots should be flexed twice at interval of 30 seconds. At the end white cotton socks are checked for any staining.

Bond Test (DMS)

This test carried out to check the bond between the sole and the upper of the boot DMS. Boot should not show no visible parting of bottom and upper toe at a pressure of not less than 27 Kg and should not show no visible parting of bottom and upper at heel at a pressure of not less than 32 Kg.

Bond Test (DD)

The bond strength shall not be less than 4.0 N/mm, unless there is tearing of the sole, in which case the bond strength shall not be less than 3.0 N/mm when tested as per ISO 20346:2004 (E) and ISO 20344:2004 Standards

Tensile Strength of Leather

Minimum load per unit area of test piece required to stretch the piece to its breaking point is called tensile strength. A dump bell shaped piece is cut from sample, clamp the specimen in the jaws of tensile strength machine is such a way so that the load when it is applied is directed along the central axis of specimen, note the load rupture the sample and calculate as per formula.

$$\text{Tensile strength} = \frac{\text{Load}}{\text{Thickness} \times 0.5 \times 2.54 \times 2.54 \times 2.2}$$

Thickness = Ave Thickness of leather of dump bell piece

0.5 = Factor of ______

2.54 = Conversion of inch to cm

2.2 = Conversion from lbs to Kg

TS = _______ Kg / cm ^{2}

Shrinkage% of Leather

This test is carried out only in material samples. A specimen of 3 inch dia is taken marked with two lines at x-axis and y-axis. Immerse that specimen water at room temperature for 24 hours. After that place it in boiling water for 3 minute. Measure the marked diameters again and calculate as under: -

Shrinkage% = $D- D_1 \times 100 / D$

D = Initial diameter of specimen.

D_1= Final dia of the specimen

Chromium % as Cr_2O_3 in Leather

This test is carried out only in the chrome-tanned leather like leather used in Boots DMS. Following are the test steps to estimate the Chromium % in the leather.

1. Take 5 gm prepared sample in silica dish.

2. Make ash of the sample at temp 700 to 800 ^{0}C
3. Transfer the ash into a beaker and add 50ml distilled water.
4. Add 20 ml HNO_3 (conc) and boil. Add 8 gm $KClo_{3.}$
5. Dry it till no nitrous fumed is left and add 50 ml of distilled water.
6. Neutralized it by NH_4OH and dry it again.
7. Add 10% solution of H_2SO_4 and make volume up to 300 mm and boiled .
8. Draw 50 ml in iodine flash add 10 gm of KI.
9. Sealed the flask and put it in the ddrak place for 15 minute then titrate it against sodium thiosulphate N/10using starch as indicator.
10. Calculation = Consumption x10x100x (Factor of thiosulphate) x0.002534 / wt of sample

Water Resistivity.

A pair of white cotton socks of an appropriate size, properly stuffed with some suitable material shall be inserted in the boot. The boot shall then be immersed in water containing a water level up to lower edge of third speed lacing hook from top. Boot tested should show signs of wetting on socks / seepage of water at interval of 30 min.

Glossary

Aniline:

Leather that is colored all the way through with a transparent dye. The effect is applied by immersing the leather in a dye bath. Because Tongue the finish is transparent and shows the natural markings of the leather, only the best quality hides can be used.

Antiqued: Leather that is dyed with one color over another (usually darker over lighter) so as to create rich highlights and an artificial aged appearance. Also called **distressed** leather.

Buffed Leather: Leather from which the top surface has been removed by abrasion. Often known as suede or nubuc.

Corrected Grain: Leather that has been buffed to remove blemishes, then covered with a new, artificial grain created using pigments and other finishes.

Back Seam - The vertical seam at the center of the back of a shoe or boot.

Ball - The padded area of the foot between the big toe and the arch of the foot.

Break - The natural crease created across the vamp of the shoe from everyday wear.

Crocking: Removing the crock, or excess coloring, that rubs off of a newly-dyed hide.

Crust: Leather which has been tanned (treated to become nonperishable) but not colored or otherwise finished.

Collar - The material sewn into the opening, or the topline, of the shoe. The collar can be padded to provide increased support or comfort.

Curing - The application of chemicals to animal hides in preparation for the tanning process.

Cushioning - Padding on the insole or outsole of a shoe for added comfort and stabilization

Distressed: Another term for **antiqued** leather.

Drum Dying: The process of coloring leather by tumbling it in a rotating drum immersed in dye. A very effective method allowing maximum dye penetration.

Derby - Also Known as Blucher or Gibson - A shoe with two side panels or "quarters" which are laced together over the tongue. The lacing is 'open-throat' (not stitched together at the bottom) and allows for more adjustment or 'give' around the instep than 'closed-throat' 'Oxford' 'V'-shaped lacing.

Dressing - The application of polish or gloss to a shoe to maintain its finish and appearance.

Embossed Leather: Leather that has been "stamped" with a design or artificial texture under very high pressure. Used, for example, to create imitation alligator hide.

Eyelet - A hole through which a lace is threaded; may be reinforced with a metal ring or grommet

Finish: Any enhancing effect applied to leather after it has been tanned. Examples are dyeing, **embossing**, **buffing**, **antiquing**, waxing, waterproofing, and so on.

Full Grain Leather: Leather which has not been altered beyond hair removal. Full grain leather is the most genuine type of leather, as it retains all of the original texture and markings of the original hide.

Flat Foot - A condition in which the arch of the foot is collapsed and the entire foot rests on the ground.

Foot bed - The insole of the shoe, where the foot rests. Another term for insole.

Forefoot - The area of foot between the ball and the toes.

Foxing - A strip of rubber joining the upper and sole of a shoe. Typically found on canvas sneakers.

Glazed Leather: Aniline-dyed leather which has been polished to a high luster by passing through glass or steel rollers under great pressure.

Glove Leather: Lambskin or other very soft leather typically used for gloves.

Grain: A word used to describe the natural characteristics of an unprocessed hide, such as its pores, wrinkles, markings, and texture.

Girth - The circumference of a shoe last measured around the ball of the foot.

Gore - An elastic panel stitched into either side of a shoe's vamp in order to make it more comfortable and easier to put on and take off.

Hand: A word used to describe the feel (i.e. softness or fullness) of leather, typically upholstery leather.

Heel Breast - The forward-facing side of the heel.

Heel Height - Heel height is measured on a vertical line at the breast of the heel, and goes from the bottom surface of the sole (where it meets the heel) to the floor. Heel height is traditionally measured in increments of 1/8th inches, so for example an 8/8 heel is 1" high.

Heel Seat - The part of the shoe directly below where the heel of the foot rests, and where the sole and the heel are joined together

Instep - The area of the foot between the toes and the ankle, or the top front part of a shoe

Laces - A strip of material strung through the eyelets of a shoe in order to pull the shoe closed and adjust its girth.

Lambskin - Leather created from the skin of young sheep.

Last - The wooden block around which the shoe is formed. The last represents the shape and size of the intended wearer's foot. Last's can be standard sizes or bespoke.

Lasting - The process of pulling and shaping a shoe on a last.

Lift - One of the several layers of leather or leather-board used make a heel.

Lining - The inside material of a shoe. May be composed of leather, fabric or synthetic material.

Loafers - Also referred to as Moccasins, they are slip-on shoes noted for their comfort. The shoe's construction tends to be simple and 'roomy', and are constructed completely without fasteners

Nap: Describes the soft, "fuzzy" effect achieved in leather by **buffing** or brushing.

Natural Grain: A leather that displays its original **grain**.

Nubuc: A leather whose surface has been **buffed** and brushed to create a soft, velvety effect. Differs from **suede** in that while suede is created from the flesh (inner) side of a hide, nubuc is created using the grain (outer) side, giving it added strength and durability.

Napa or Nappa Leather - A supple version of sheepskin leather. A type of leather characterized by its stretchy, soft, smooth texture

Nailed Construction - Refers to shoes that have their pieces nailed together, instead of sewn.

Oil Tanned: Leather that is tanned using oils to create a very soft, pliable finish.

Orthotic - An orthopedic insole designed to cushion and stabilize the foot.

Oxford - A style of shoe where the two flaps of leather with the piercings for the laces ("quarters") are stitched together at the bottom underneath the vamp.

Patina: The aura or luster that develops in a quality piece of leather with age.

Pigmented Leather: Leather that has been coated with a flat surface color on top of or instead of the usual dye finish. Leather is usually pigmented to add durability and hide natural blemishes.

Plating: The process of pressing leather under a heated plate. Often used in upholstery leather to mask imperfections.

Pull-up: Describes the behavior of leather that has been treated with oils, waxes, and dyes in such a way that when the leather is pulled or stretched (i.e. on upholstery), the finish becomes lighter in the stretched areas. Considered a mark of high quality.

Perforation - A pattern of small holes punched or bored into the trim of a shoe, for the purpose of decoration or ventilation.

Piping - A decorative, narrow strip of leather that typically follows the seam of a shoe.

Retan: A second **finish** added over an underlying tannage.

Rim - The part of the shoe where the foot enters. Another term for collar or top line

Sauvage: A coloring effect created by blending two similar dyes to create a mottled or marbled appearance.

Semi-Aniline: **Aniline** leather to which a matching **pigment** layer is added to even out the color and add protection.

Side Leather: Leather made from one half, or "side", of a full hide. Typically refers to leather whose top **grain** (outermost layer) has been left intact.

Split Leather: Leather made from the lower (inner or flesh side) layers of a hide that have been split away from the upper, or **grain**, layers. Split leather is more fragile than **side leather** or **full-grain leather**, and is typically used in the form of **suede**.

Suede: **Split leather** that has been **buffed** and brushed to create a fuzzy surface feel.

Shank - A metal strip extending from the heel to the ball of the foot to strengthen shoe and add support.

Shoe Horn - A curved metal or synthetic device used to aid in slipping the foot into a shoe.

Shoe Sizes - A variation between full sizes is one-third of an inch, while the difference between half sizes is one-sixth of an inch.

Top Grain: Leather whose top (outermost) layers have been left intact, in contrast to **split leather**.

Two-tone: An effect created by applying layers of similar or contrasting dyes to a piece of leather in order to create a mottled or aged appearance. **Antiqued** and **Sauvaged** leathers are examples of two-tone leathers.

Toe-box - A stiff piece of material placed inside the vamp to retain the dome-like shape over the toes. It can take many shapes, flat, high, wide, etc.

Tongue - A strip of leather or other material sewn into the vamp of a laced shoe and extending to the throat of the shoe.

Tread - May refer to the design of a shoe's sole or the way in which a shoe's sole is worn.

Upholstery Leather: Leather created from a whole hide and intended for use in furniture, automobiles, airplanes, and other upholstery applications.

Vegetable Tanning: A method of hide tanning which utilizes materials from organic materials such as bark instead of the traditional chemicals. Vegetable tanned leather has greater body and firmness than traditionally-tanned leather.

Weight: A term which describes the heaviness or thickness of leather. Typically given in ounces per square foot or millimeters (thickness).

Whole Hide: Refers to leather created using a full hide, as opposed to a **side**, and typically intended for use as **upholstery leather**.

Vamp - The front part of a shoe upper that covers the toes and part of the foot.

Waterproof Leather - Shoes that have been specifically treated to prevent the entry of water.

Welt - A strip of leather sewn between the insole and the outsole to create greater durability. The welt can be made to ‘stick out’ from the sole and further ornament the shoe.

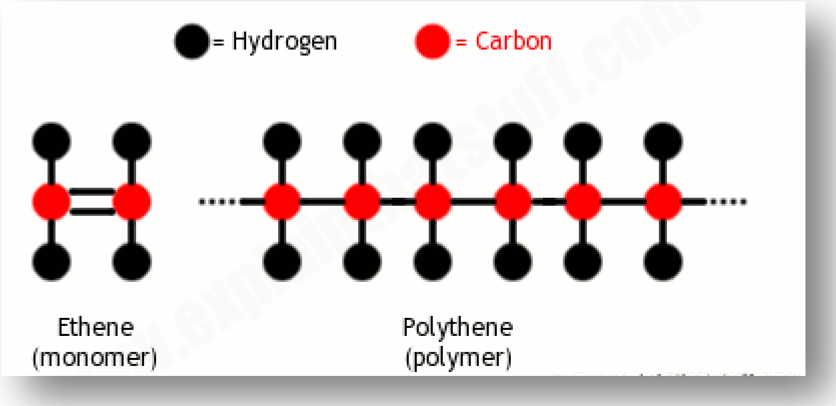
Width - Width is measured at the ball of the foot, in 1/6-inch increments and is often expressed in letters (AA=narrow, B=medium, D=wide)

UNIT 3 - PLASTIC

Chapter-1

Plastic

The word ***plastic*** derives from the Greek (*plastikos*) meaning "capable of being shaped or molded" and, in turn, from (*plastos*) meaning "molded".Plastic is material consisting of synthetic or semi-synthetic organic compounds ,most commonly derived from petrochemicals



Due to their low cost, ease of manufacture, versatility, and imperviousness to water, plastics are used in a multitude of products of different scale,. They have prevailed over traditional materials, such as wood, stone, horn and bone, leather, metal, glass, medical field and ceramic, in some products previously left to natural materials.

Virgin Plastic.

Virgin plastic is the resin produced directly from the petrochemical feedstock, such as natural gas or crude oil, which has never been used or processed

Recycled Plastics.

Plastic is being recycled all over the world. It is cost effective and helps in minimizing the waste, however, it cannot be used in all types of appl. It is pertinent to mention here that recycled plastics products are of two types i.e. products which are made from recycled virgin plastics while other type of products are made from recycling of various types of plastics incl waste

Properties and Classifications

Plastics are usually classified by: the chemical structure of the polymer's backbone and side chains; some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics.

Plastics can also be classified by their various physical properties, such as: hardness, density, tensile strength, resistance to heat and glass transition temperature, and by their chemical properties, such as the organic chemistry of the polymer and its resistance and reaction to various chemical products and processes, such as: organic solvents, oxidation, and ionizing radiation. In particular, most plastics will melt upon heating to a few hundred degrees celsius. Other classifications are based on qualities that are relevant for manufacturing or product design i.e thermoplastics and thermosets.

1. **Thermoplastics**

   Thermoplastics are the plastics that, when heated, do not undergo chemical change in their composition and so can be molded again and again.

2. **Thermosets**

   Thermosets, or thermosetting polymers, can melt and take shape only once: after they have solidified, they stay solid. In the thermosetting process, a chemical reaction occurs that is irreversible. Vulcanization, the product is rigid and non-tacky.

Types of Plastic Polymer , Properties and Uses

Polymer	**Properties**	**Used in**
High Density Polyethylene (HDPE)	Stiffness, strength, toughness, resistance to moisture, permeability to gas	Water pipes**,** Gas & Fire Pipelines, Electrical & Communications conduit, , five gallon buckets**,** milk/ juice bottles
Polyethylene Terephthalate (PET)	Most transparent, strength, toughness, barrier to gas and moisture	Mostly used in food grade items i.e. Soft drink, water and salad dressing bottles
Low Density Polyethylene (LDPE)	Ease of processing, strength, toughness, flexibility, ease of sealing, barrier to moisture	Frozen food bags, squeezable bottles, e.g. honey, mustard; cling films; flexible container lids
Polyvinyl chloride (PVC)	Versatility, ease of blending, strength, toughness	Cables, pipes and floorings
Polypropylene (PP)	Strength, toughness, resistance to heat, chemicals, grease and oil, versatile, barrier to moisture	Reusable microwaveable ware; kitchenware; yogurt containers; margarine tubs
Polystyrene (PS)	Versatility, clarity and easily formed	Egg cartons, packing peanuts, disposable cups, plates, trays and cutlery disposable take-away containers

Additives

Blended into most plastics are additional organic or inorganic compounds. The average content of additives is a few percent. Typical additives include:

1. **Stabilizers**

   Polymer stabilizers prolong the lifetime of the polymer by suppressing degradation that results from UV-light, oxidation, and other phenomena. Typical stabilizers thus absorb UV light or function as antioxidants.

2. **Fillers**

   Many plastics contain fillers, to improve performance or reduce production costs. Typically fillers are mineral in origin, e.g., chalk. Other fillers include: starch, cellulose, wood flour, ivory dust and zinc oxide.

   Plasticizers

3. Plasticizers are, by mass, often the most abundant additives. These oily but nonvolatile compounds are blended in to plastics

4. **Colorants**

   Colorants are another common additive, though their weight contribution is small.

Toxicity

Pure plastics have low toxicity due to their insolubility in water and because they are biochemically inert, due to a large molecular weight. Plastic products contain a variety of additives, some of which can be toxic. Traces of these compounds can leach out of the product. Whereas the finished plastic may be non-toxic,

Virgin Plastic Products Vs Recycled Products

Plastics when recycled, are melted together, they tend to separate oil and water and set in the layers. This is usually covered under the combined effect of the thermal and stress (i.e. processing, ageing and recycling op) which degrade the basic properties of the polymer such as flow behavior (MFI), tensile str, elongation and impact resistance etc. This caused structural weakness in the resulting material, meaning that polymer blends are gen inferior to those of the virgin polymer and useful in only ltd appl. Recycle material properties mostly have less than the virgin plastic

1. **Adv of Recycled Plastic**
   a. Cheaper in price
   b. Minimizes the pollution
   c. Protects the envmt
   d. Minimize the global warming
   e. Conserve natural resources
   f. Recycling cuts down amount of waste in landfill sites
   g. Reduces energy consumption

2. Disadvantages of Recycled Plastic

   a. **Shelf Life**. Less shelf life/ durable. Shelf life of recycled polymer is unpredictable so it can cause catastrophic breakage.

   b. **Weak Str**. Recycled plastic is down cycling, therefore, binding forces b/w molecules reduce and as a result molecular structure becomes weaker and less usable product is mfr.

   c. **Non-Recyclable**. Recycled plastic pallet is gen unfit for another rd of recycling. Reproducing of recycled resins from plastic wastes remains a big challenge.

d. **Brittleness**. Recycled resins are more brittle than virgin resins counterpart as the qual of recovered plastic is typically lower than that of virgin plastics.

e. **Cumbersome**. In recycling of wastes, recycling materials of various densities are being processed together, hence, resulting product is heavier.

f. **Difficult to be Indent**. Being mixture of various polymers bearing diff densities, hence, grade of material is not definable and qual of end product cannot be ascertained.

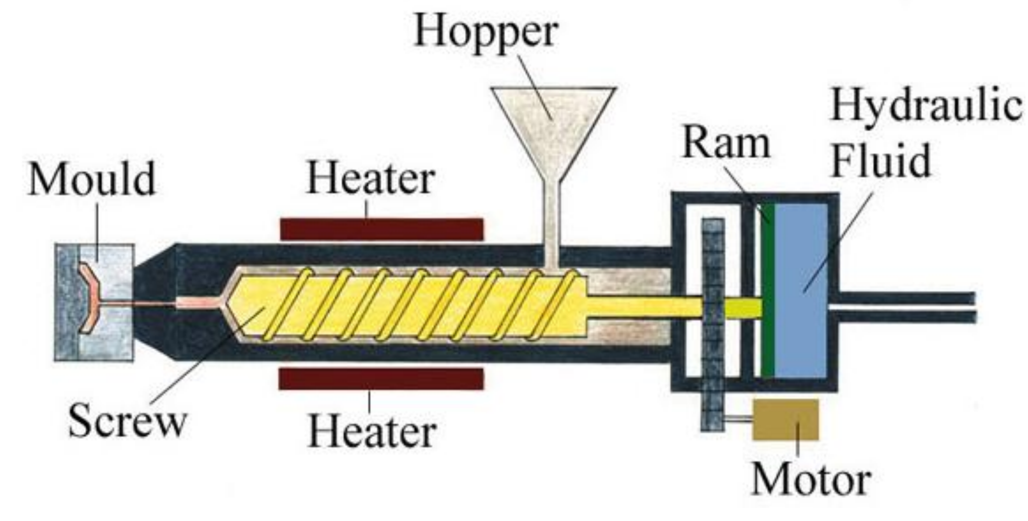
g. **Melt Flow Index (MFI)**. MFI plays an imp role in mfr of plastic product. On the basis of MFI, production rate of the product is defined. Virgin resins have a std MFI whereas; MFI of recycle plastic is very difficult to define.

Plastic Molding Process.

1. Plastic molding processes are as:-
2. Injection
3. Compression
4. Extrusion
5. Blow
6. Extrusion Blow

    1. **Injection Molding**.

    In injection molding, material is fed through a hopper into an extruder, where a reciprocating screw mixes and melts the material then injects it into a mold. Once the plastic has cooled, the object is rel and then the process begins all over again.



Adv of Injection Molding.

a. Good Product Consistency.
b. Design flexibility.
c. High-output production.
d. Multiple materials can be used at the same time.

e. Can be used to produce very small parts

f. Good colour control.

g. Reduced req for finishing.

h. Excellent visual appearance

Disadvantages of Injection Molding.

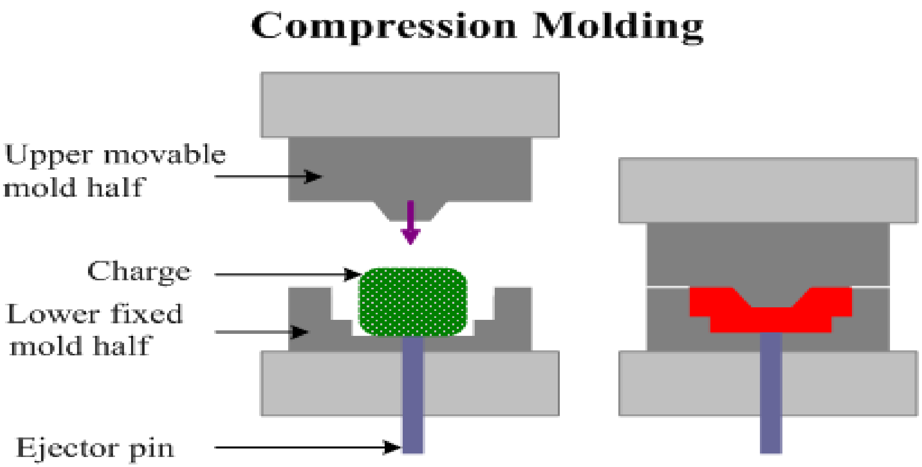
a. High initial tooling and machinery cost.

b. Design changes are costly

c. Longer lead times than other technologies

2. Compression Molding

Compression Molding is a method of molding in which the molding material, gen preheated, is first placed in an open, heated mold cavity. The mold is closed with a top force or plug member, pressure is applied to force the material into contact with all mold areas.



Advantages of Compression Molding

a. Lower cost tooling.

b. Less wastage of material.

c. Suitable for large parts.

d. Good for small product run.

Disadvantages of Compression Molding.

a. Poor Product Consistency.

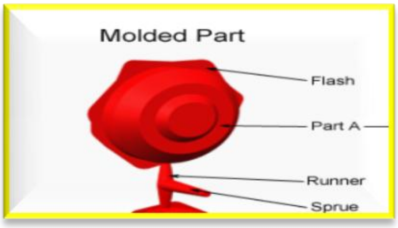
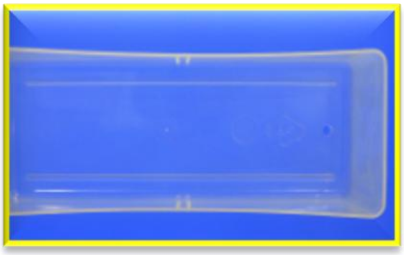
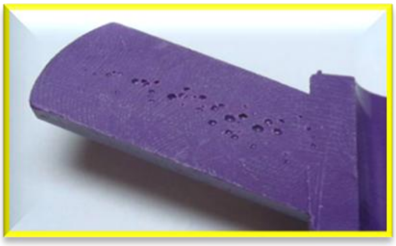
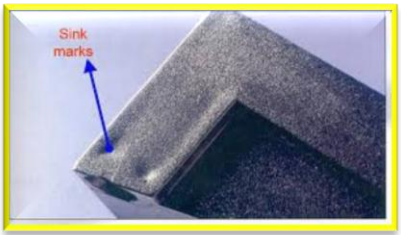
b. Higher labor cost.

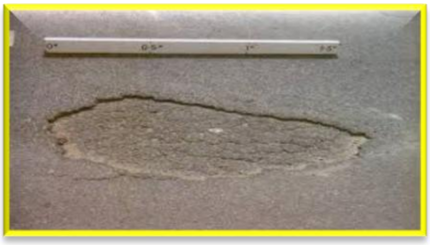
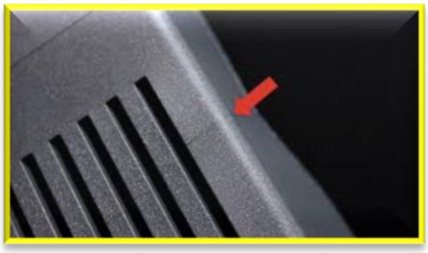
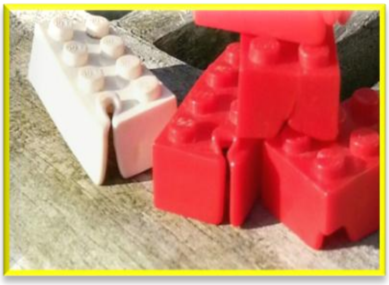
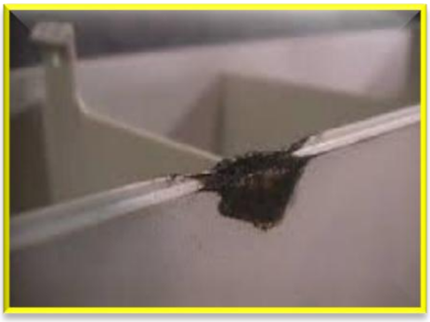
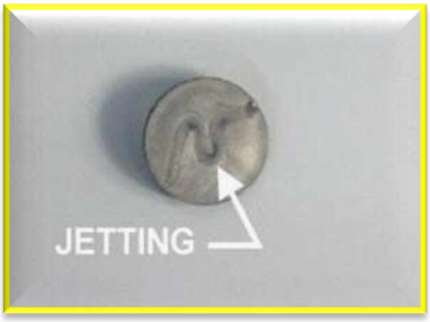
c. Difficulty in controlling flashing.

d. Max amount of energy req to heat the material.

e. Rrapid cooling required after the material has been compressed into the mold.

Defects of Plastic

Defects	**Detail**	**Pictures**
Flash	The occurrence of molten material seeping out of the mold cavity and solidifying. Once the part is ejected, a thin layer of material will have formed attached to the part along the parting line.	
Warping	Warping is the deformation that occurs when there is uneven shrinkage in the different parts of the molded component.	
Bubbles	Bubbles are either pockets of trapped gas or vacuum voids. Trapped air is a root cause of bubbles as well as blisters.	
Sink marks	Sink holes are what occur when the surface of a part caves into a cavity or void, and sink marks are depressions in the surface of a part caused by internal shrinkage due to varying part cooling times	
Ejector marks	A part defect in the form of small indentations that are made where the ejection system pushed the part out of the mold	
Flow Lines	Flow lines are streaks, patterns, or lines - commonly off-toned in color	
Vacuum Voids	Vacuum voids are pockets of air trapped within or close to the surface of an injection molded prototype.	

Surface Delamination	Surface delamination is a condition where thin surface layers appear on the part due to a contaminant material. These layers appear like coatings and can usually be peeled off (i.e. “delaminate”).	
Weld lines	Weld lines are actually more like a plane than a line that appears in a part where molten plastics meet each other as they flow from two different parts of the mold	
Short Shot	As the term implies, short shots can be described as a situation where a molding shot falls short. This means that the molten plastic for some reason does not fully occupy the mold cavity or cavities, resulting in a portion where there is no plastic. The finished product becomes deficient because it is incomplete	
Burn Marks	Burn marks are caused either by the degradation of the plastic material due to excessive heating or by injection speeds that are too fast. Burn marks can also be caused by the overheating of trapped air, which etches the surface of the molded part	
Jetting	Jetting refers to a situation where molten plastic fails to stick to the mold surface due to the speed of injection.	

Chapter-2

Testing of Plastic Pallet

1. Following tests to be carried out for t Pellet as per ISO 8611.
    a. **Stacking Test**
        (1) Bending Strength
        (2) Bending Stiffness
    b. **Fork Lifting Test**
        (1) Bending Strength
        (2) Bending Stiffness
    c. **Compression Test**
        (1) Bending Strength
        (2) Bending Stiffness
    d. Slip angle test
    e. Drop test
    f. Impact test
        (1) Top deck
        (2) Block
        (3) Shear
    g. Static coefficient of friction test
    h. Static shear test
2. All pallets should be tested after 72 hrs of manufacturing and conditioning.

Stacking Test

a. ISO 8611 will be followed for testing details. This test will be performed either from frontal or lateral side.

b. **Strength.** Load will be applied until breakage occurs in one or more components of pallet and that load will be noted as ultimate load.

c. **Stiffness.** 50% of ultimate load will be applied.

    (1) Y_1 will be taken when no load is applied.
    (2) Y_2 will be taken after 30 min. when 50% of ultimate load is applied.
    (3) Y_3 will be taken after 30 min. relaxation when load is removed.

d. **Pass/Fail Criteria**

$\Delta Y = Y_2 - Y_1$ should be less than or equal to 15 mm.

$\Delta Y = Y_3 - Y_1$ should be less than or equal to 7 mm.

4. **Fork Lifting Test**

   a. 5 x metal plates will be placed on Pallet in a way that 4 x plates to be placed at each corner and 1 x plate at center top of 4 x plates. Size of metal plates will be 370 x 445 mm.

b. 2 x metal bars having width of 100mm will be placed under Pallet with a distance of 470mm between their outer edges as shown in picture.

c. ISO 8611 will be followed for testing details. This test will be performed either from frontal or lateral side.

d. **Strength.** Load will be applied until breakage occurs in one or more components of Pallet and that load will be noted as ultimate load.

e. **Stiffness.** 50% of ultimate load will be applied.

   (1) Y_1 will be taken when no load is applied.

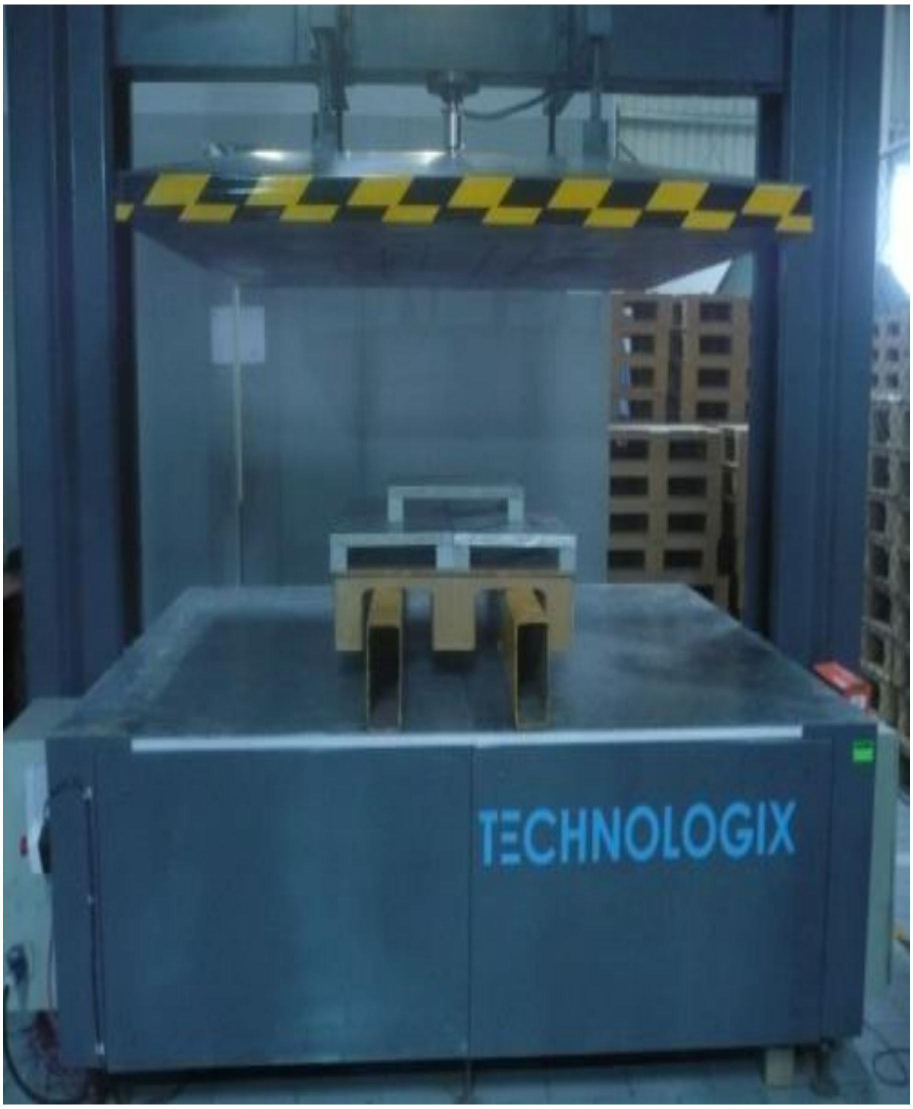
   (2) Y_2 will be taken after 30 min. when 50% of ultimate load is applied.

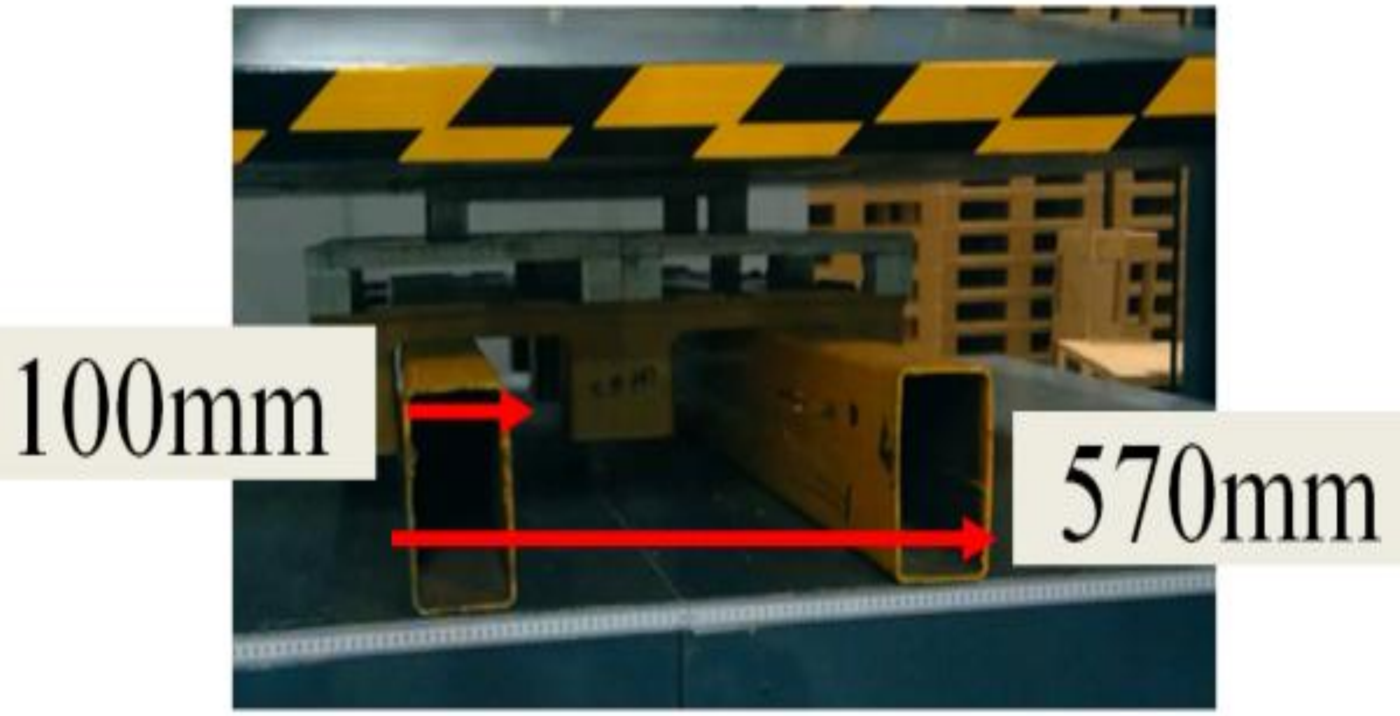
   (3) Y_3 will be taken after 30 min. relaxation when load is removed.

f. **Pass/Fail Criteria**

   (1) $\Delta Y = Y_2 - Y_1$ should be less than or equal to 20 mm.

   (2) $\Delta Y = Y_3 - Y_1$ should be less than or equal to 7 mm.





5. **Compression Test**

   a. The purpose of this test is to determine the compression stiffness and strength of the blocks or

   b. Stringers of the pallet. Blocks or stringers supporting superstructures or heavy rigid loads shall be tested.

   c. Place the pallet in a normal position on a flat, hard, rigid and horizontal surface. Place a rigid load applicator of dimensions 300 mm × 300 mm × (25 mm ± 5 mm), over a block or a portion of a stringer .Apply the load until breakage occurs in one of the blocks or stringers of the pallet or upon reaching an excessive deflection or deformation. Record the ultimate load.

   d. ISO 8611 will be followed for testing details. This test will be performed either from frontal or lateral side.

   e. **Strength.** Load will be applied until breakage occurs in one or more components of Pallet and that load will be noted as ultimate load.

   f. **Stiffness.** 50% of ultimate load will be applied.

      a. Y_1 will be taken when no load is applied.

      b. Y_2 will be taken after 30 min. when 50% of ultimate load is applied.

      c. Y_3 will be taken after 30 min. relaxation when load is removed.

   f. Pass/Fail Criteria

      (1) $\Delta Y = Y_2 - Y_1$ should be less than or equal to 4 mm.

      (2) $\Delta Y = Y_3 - Y_1$ should be less than or equal to 1.5 mm

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6. Slip Angle Test

a. This test is conducted to see the angle at which test box commences to slips out. Pallet Placed on slip angle machine. It will be checked that test box will not slip out

b. ISO 8611 will be followed for details and guidance in testing. This test will be performed either from frontal or lateral side.

c. **Pass / Fail Criteria**

Shall not slip out Pallet as per req std

7**.** Drop Test

a. It is performance test only and have pass fail criteria at 0.5 m only. The purpose of this test is to determine the rigidity of the Pallet and its resistance to impact.

b. **Pass / Fail Criteria**. Pallet shall be examined for the fol:-

(1) Any breakage / deformation / damage that limits the performance or functionality / un-serviceability of Pallet.

(2) Deformation should not exceed $\Delta Y \leq 4\%$ when dropped from height of 0.5 m.

(3) 5 cm crack on each part (leg & top) or total of 10 cm is acceptable when tested for Corner Drop test at 2 mtr ht.

Note: Drop test is potentially dangerous for the test performers because movement of heavy mass at high speed. Special safety measures should be taken to reduce risks to both operators and observers.

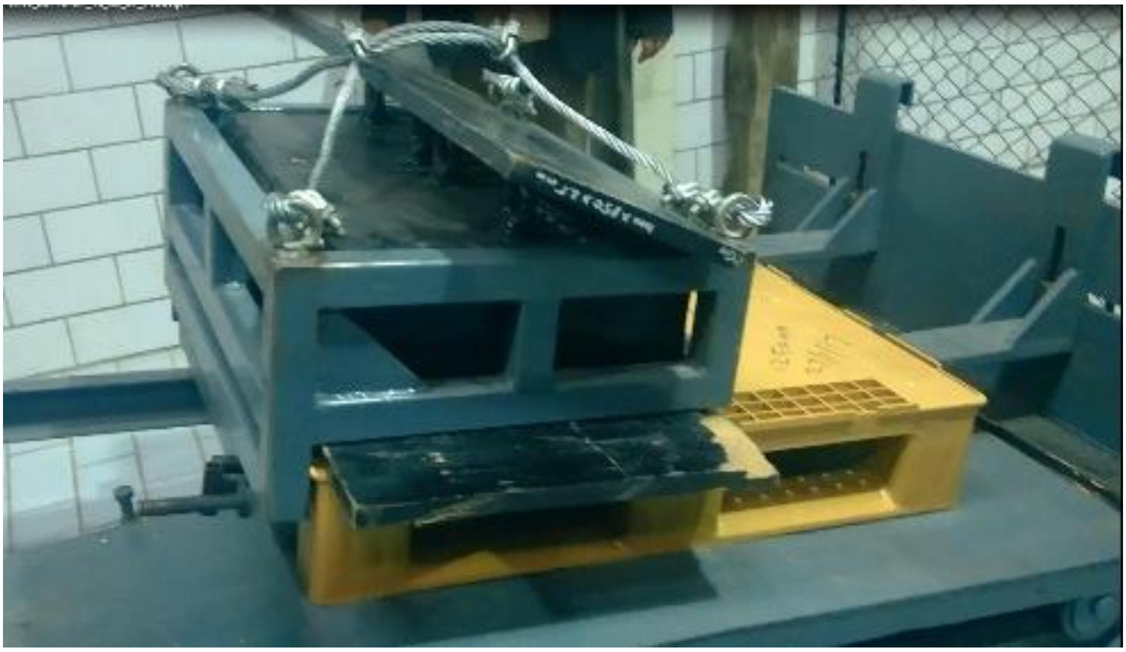
8. **Impact Test (Top Deck , Block And Sheare)**

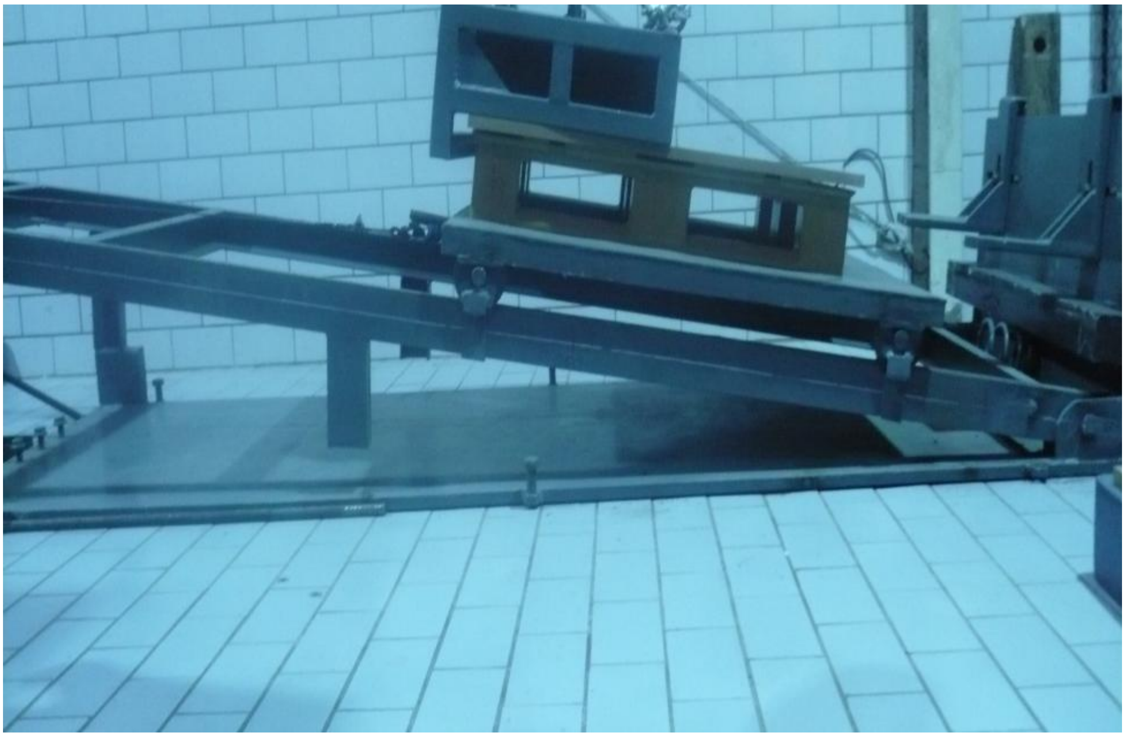
   a. It is performance test only and do not have any pass fail criteria. The purpose of this test is to determine the resistance of blocks to impact by the Arms of forklift for any breakage / deformation / damage that limits the performance or functionality of the Pallet when impact tested at a distance of 1250 mm.

   b. ISO 8611 will be followed for testing details. This test will be performed either from frontal side.

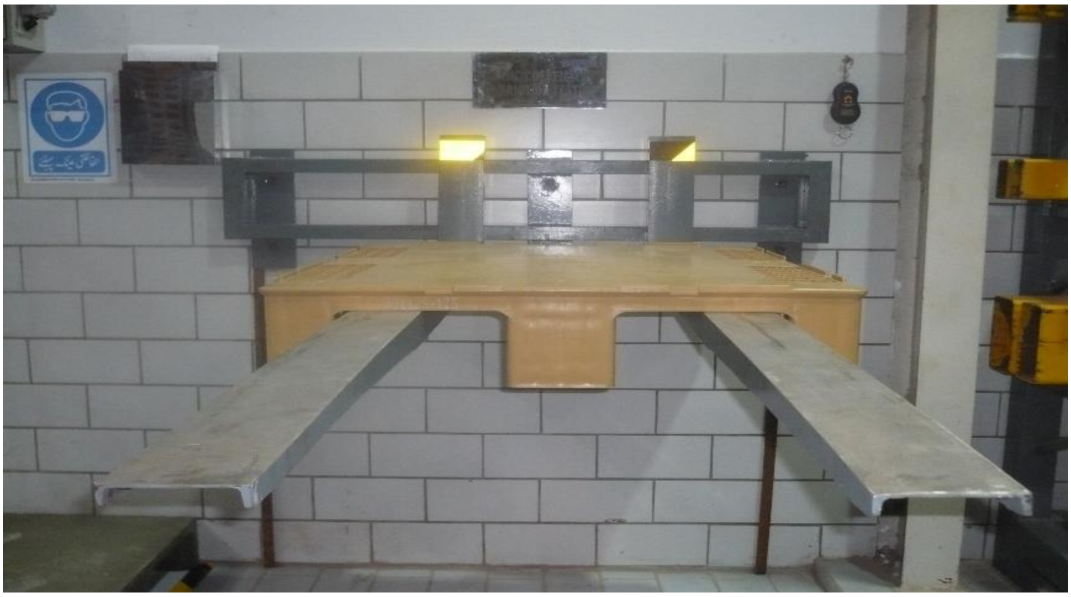
Note: Inclined plane tests is potentially dangerous for the test performers because movement of heavy mass at high speed. Special safety measures should be taken to reduce risks to both operators and observers.

Lot # 3
Top Deck
1250mm
impect Test

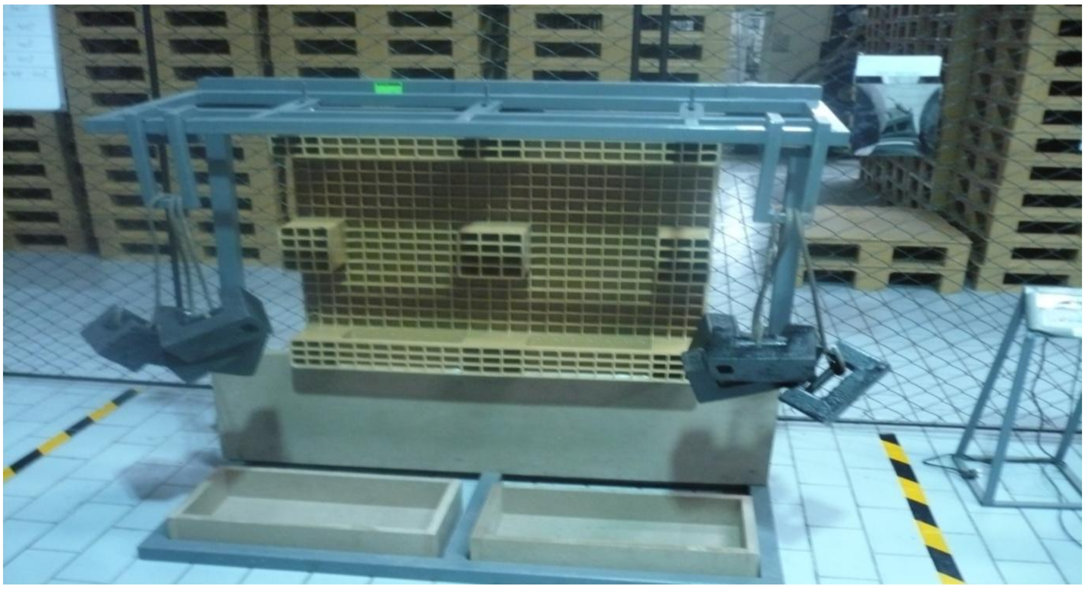




9. **Static Coefficient of Friction Test**
   - a. It is performance test only and do not have any pass fail criteria
   - b. The purpose of this test is to determine the static coefficient of friction between the underside of the top deck and the forks of fork lift trucks. The test is conducted using an unloaded pallet because this result can be used to predict the slip of large masses
   - c. ISO 8611 will be followed for testing details. This test will be performed either from frontal side



10. **Static Shear Test**
    - a. It is performance test only and do not have any pass fail criteria
    - b. The purpose of this test is to simulate the approximate forces induced through lateral deck shear.
    - c. ISO 8611 will be followed for testing details. This test will be performed either from frontal side
    - d. Distortion (change in y) shall be measured after release of load and after a relaxation period.



Chapter-3

Testing of Plastic

Chemical Analysis of Plastic

Basic identification of plastic can be accomplished by using three analytical tests. FTIR Analysis (ASTM E1252) can be used to identify the major polymer type. A typical summary statement for a basic material identification report might read "The FTIR analysis of the sample was consistent with that of a polycarbonate with 10% glass filler." This combination of tests provides basic information but additional testing is needed if identification of a trace additive or the grade of plastic is required.

Mechanical Testing of Plastic

There are a wide variety of tests used for mechanical testing of plastics but some of the most common are

1. Tensile Properties
2. Flexural Properties
3. Izod Impact Strength

Mechanical testing is most often performed on molded test bars but we also have a complete Machine Shop so we can fabricate test bars out of parts.

Thermal Analysis of Plastic

Characterizing the thermal properties of plastic is important to make sure that it will process correctly and that it will stand up to the service temperature of your application.

Common Tests of Plastic

1. **Density**

   The density of plastic is determined by placing test specimens in water and adding isopropanol (or other liquid if sample density > 1 kg/m3) until the plastic sample achieves a neutral buoyancy in the solution. The density of plastic and other non-absorbent materials such as glass in finished form can be determined by weighing a sample in air, and in a test liquid, using a balance and pan straddle.

2. **Flexural Strength**

   The flexural strength of a material is defined as its ability to resist deformation under load. For materials that deform significantly but do not break, the load at yield, typically measured at 5% deformation/strain of the outer surface, is reported as the flexural strength or flexural yield strength. The test beam is under compressive stress at the concave surface and tensile stress at the convex surface. Tests also give the procedure to measure a material's flexural modulus (the ratio of stress to strain in flexural deformation).

3. **Tensile Properties**

   Tensile properties (such as tensile strength, yield strength, % elongation, elastic modulus, and tensile energy absorbed) on plastic sheet. Tensile testing is used to characterize and compare the performance of plastic materials separately in machine and cross (transverse) material directions.

4. **Melt Flow Index**

   Melt Flow Indexer is used to measure the flow rate of different polymers. The reported Melt Index values helps to distinguish between the different Grades of Polymers. This is due to the fact that plastic materials are seldom manufactured without incorporating additives, which affect the processing characteristics of material like stability and flow ability.

   Melt Flow Index (**MFI**) is a measure of how many grams of a polymer flow through the die in ten minutes. Thermoplastic materials can be evaluated using the MFI method of analysis. As well as Melt Flow Rate (MFR) and Melt Volume Rate (MVR)

5. **Izod Impact**

   Test methods cover the determination of the resistance of plastics to "standardized" pendulum-type hammers, mounted in "standardized" machines, in breaking standard specimens with one pendulum swing. The standard tests require specimens made with a milled notch. The results are reported in terms of energy absorbed per unit of specimen width or per unit of cross-sectional area under the notch

6. **Deflection Temperature**

   The deflection temperature is a measure of a polymer's ability to bear a given load at elevated temperatures. The deflection temperature is the temperature at which a test bar, loaded to the specified bending stress, deflects by 0.010 inch (0.25 mm).

   The value obtained for a specific polymer grade will depend on the base resin and on the presence of reinforcing agents..

   The deflection temperature test results are a useful measure of relative service temperature for a polymer when used in load-bearing parts. However, the deflection temperature test is a short-term test and should not be used alone for product design. Other factors such as the time of exposure to elevated temperature, the rate of temperature increase, and the part geometry all affect the performance.

Identification of Plastic by Burning

Many plastics look and feel alike Burning plastics can give off toxic fumes and plastic drips are very hot. Here are some common plastic and the ways that you may be able to identify them

1. **Thermoplastics**

   a. ABS(Acrylonitrile Butadiene Styrene)

   ABS has an acrid smell when a heat source is applied. The flame is yellow with blue edges and will not drip. ABS will continue to burn when the flame source is removed and the odor continues to be acrid, the flame color is the same yellow with blue edges and the material will drip. The rate of burning is slow and black smoke with soot is admitted into the air.

   b. **Nylon**

   Nylon is an off-white plastic material. It is fairly hard and cannot be marred with a fingernail. When burned it gives off the odor of burnt wool or hair. The flame is blue with a yellowish tip. Additionally, the material drips when flame is applied. It will continue to burn slowly after the flame source is removed.

c. **Polycarbonate**

Polycarbonate gives off a faint, sweet aromatic ester smell. The flame is orange in color and PC will drip when a flame is applied. The smoke is black and gives off soot into the air.

d. **Polypropylene**

Polypropylene smells acrid when a flame is applied and the flame is yellow in color. It will continue to burn after the flame source is removed giving off a sweet smell. The flame at this point is blue with a yellow tip. PP produces drips as it continues to burn slowly. When bent, polypropylene sheet will turn white on the crease line. Interestingly, PP floats in water.

e. PTFE (polytetrafluoroethylene)

PTFE is a fluorocarbon. It is very white and has a waxy feel. It is also fairly soft. You can mar it with your thumb nail. A piece of PTFE with no flame applied gives off the faint smell of burned hair. When a flame is applied, the material does not drip. PTFE has one of the lowest coefficients of friction of all the thermoplastics. When rubbed against a surface, it will slide easily but will not wear well.

2. **Thermosets**

a. Polyesters

Polyesters**,** when burned, smell of hydrochloric acid and the flame is yellow in color. There are no drips. Polyesters are flame retardant. When the flame source is removed the material will continue to burn. The smell is nondescript but the flame is a yellow color with blue edges. Again. there are no drips and the material burns slowly. Polyesters will crack and break when flame is applied.

b. Phenolics

Phenolics smell like formaldehyde and phenol with no flame applied. When a flame source is present the materials will smell of phenols and wood or paper. The flame color is yellow and the material will not drip. The heat source may make phenolics crack.

Glossary

A

Acrylate resins a class of thermoplastic resins produced by polymerization of acrylic acids derivatives.

Additives a diverse group of specialty chemicals incorporated into plastic formulations before or during processing

Aging The effect of exposing plastic to a specific environment for an extended period of time.

B

Blisters undesirable rounded elevation of the surface of a plastic, whose boundaries may be either more or less sharply defined, somewhat resembling in shape a blister on the human skin. A blister may burst and become flat.

Blow molding A process for the production of hollow thermoplastic shapes. This method of fabricating involves a plastic parison (hollow tube) placed between two halves of a mold (cavity) and by using air pressure the parison is forced to take the shape of the cavity. The air pressure is introduced through the inside of the parison. The air pressure forces the plastic against the surface of the mold that defines the shape of the container.

C

Calendaring A process by which a heated rubber plastic product is squeezed between heavy rollers into thin sheet or film.

Cast “plastic” object by pouring a fluid monomer-polymer solution into an open mold where it finishes polymerizing. 2) forming plastic film and sheet by pouring the liquid resin onto a moving belt or by precipitation in a chemical bath.

Clarity freedom from haze or cloudiness in a plastic material.

Crazing fine cracks at or under the surface of a plastic.

D

Deflection Temperature the temperature at which a plastic structure will deflect a specific distance for a given loading.

Degradation a deleterious change in the chemical composition, appearance, physical or mechanical properties of a plastic.

Durometer a numerical scale for measuring the hardness of rubber or plastic based on the depth of penetration of an indenter point on the surface of a test specimen.

Drop Test any method in which the article being tested is dropped in a specific manner for a specific number or times or until the article fails from impact.

E

Elasticity the property that describes the tendency of a plastic material to return to its original dimensions after undergoing a deformation.

Embossing techniques used to create depressions of a specific pattern in plastic film and sheeting.

Environmental stress cracking the tendency of a material to craze or crack due to the combination of residual or applied stress in the material, and chemical, thermal, or electromagnetic environments.

Extrusion the method of processing plastic by forcing heat softened plastic through an opening of the desired shape of the cross-section of the finished product.

Extender a material added to a plastic composition to reduce its cost.

F

Fabricate Method of forming a plastic into a finished article by machining, drawing, and similar operations.

Filler A material added to a plastic composition to impart certain qualities in the finished article.

Fuse to join two plastic parts by softening the material by heat or solvents.

H

Haze The degree of cloudiness in a plastic material.

Head a unit of measure representing the relative energy of a flowing fluid. Commonly recorded in “feet” of fluid, it provides a convenient means of combining the pressure, velocity, and elevation energy portions of a flowing fluid.

Head Loss energy loss in a fluid as it passes through a flow passage. The loss is due to friction between fluid particles and can be expressed as a linear change in the height of a column of fluid.

Heat sealing a method of joining plastic films by simultaneous application of heat and pressure to areas in contact. Heat may be supplied conductively or dielectrically.

Hot Stamp process for marking plastic by applying a leaf to the surface through the use of hot metal dies.

I

Impact Strength the degree to which a plastic will withstand the sudden application of a load.

Impact Resistance relative susceptibility of material to fracture by stress

Injection Molding method of forming a plastic to the desired shape by forcing heat softening plastic into a relatively cool cavity where it rapidly solidifies.

Izod Impact Test a test designed to determine the resistance of a plastic material to shock loading. It involves the notching of a specimen, which is then placed in the jaws of the machine and struck with a weighted pendulum.

M

Mold the cavity or matrix into which the plastic composition is placed and from which it takes it form.

Mold Seam a vertical line formed at the point of contact of the mold halves. The prominence of the line depends on the accuracy with which the mating mold halves are matched.

N

Neck the part of a container where the shoulders cross section area decreases to form the finish.

Neck Bead a protruding circle on a container at the point where the neck meets the finish, the diameter of which usually equals the outside diameter of the closure.

O

Opaque a term describing a material or substance which will not transmit light.

P

Plasticizer a liquid or solid incorporated in natural and synthetic resins and related substances to develop such properties as resiliency, elasticity, and flexibility.

Pneumatic moved or worked by air pressure.

Polymerization chemical change resulting in the formation of a new compound whose molecular weight is usually a multiple of that of the original substance.

R

Resin an organic substance, generally synthetic, which is used as a base material for the manufacture of some plastics.

Rotational Molding A process also known as rotomolding or rotational casting is used for the manufacture of hollow plastics including large storage tanks. It involves placing a thermoplastic powder into a mold, heating the mold in an oven while rotating the mold into perpendicular axes simultaneously.

S

Shear Strength ability of a material to withstand shear stress or stress at which a material fails in shear. 2) the maximum shear strength stress that a material is capable of sustaining.

Shore Hardness resistance of a (polymer) surface to deformation.

Stabilizer a chemical substance, which is frequently added to plastic compounds to inhibit undesirable changes in the material, such as discoloration due to heat or light.

Stress Crack external or internal cracks in a plastic cause by tensile stresses less than that of its short time mechanical strength.

T

Tear strength force required to initiate or continue a tear in a material under specified conditions. 2) the force acting substantially parallel to the major axis of the test specimen.

Tensile Strength the longitudinal stress required to break a prescribed specimen divided by the original cross-sectional area at the point of rupture 9 usually expressed in lbs. per square inch), within the gauge boundaries sustained by the specimen during the test.

Thermoforming the process of heating a thermoplastic sheet to a working temperature and then forming it into a finished shape by means of heat or pressure.

Thermoplastic plastic capable of being repeatedly softened by increases in temperature and hardened by decreases in temperature. These changes are physical rather than chemical.

Thermoset a classification of plastic resin that cures by chemical reaction when heated and, once cured, cannot be resoftened by heating.

Tolerance a specified allowance for deviations in weighing, measuring, etc., or for deviations from the standard dimensions or weights.

Translucent permitting the passage of light, but diffusing it so that object beyond cannot be clearly distinguished.

Transparent Capable of transmitting light so that objects or images can be seen as if there were no intervening material.

U

UV Stabilizer any chemical compound which, when admixed with a thermoplastic resin, selectively absorbs UV rays and minimizes chemical and/or physical changes that may be engendered by UV.

V

Vacuum forming method of sheet forming in which the plastic sheet is clamped in a stationary frame, heated, and drawn down by a vacuum into a mold.

Virgin Grade Material plastic material that has not undergone any processing other than that required to prepare it for manufacturing parts.

Viscosity internal friction of a liquid because of its resistance to shear, agitation, or flow.

W

Warpage dimensions distortion in a plastic object after molding.

Weather Resistance ability of plastic to retain its original physical properties and appearance upon prolonged exposure to outdoor weather.

Welding the joining of two or more pieces of plastic by fusion of the material in the pieces at adjoining or nearby areas either with or without the addition of plastic from another source.

Y

Yield point the point at which a material will continue to elongate at no substantial increase in load during a short test period.

Yield Stress the force which must be applied to a plastic to initiate flow.